THE

ENGINEERING MAGAZINE

VOL. XIII. JULY, 1897. NO. 4.

THE UPBUILDING OF A MARINE CARRYING-TRADE.

By John Codman.

MR. LEWIS NIXON contributes to THE ENGINEERING MAGAZINE for January an article entitled, "Progress and Promise of American Ship-building." I have no comments to make on that part of it which applies to the navy, considering that his former connection with that service, and the subsequent knowledge he has gained as a naval ship-builder, should entitle his claim to authority; but, as an old merchant ship-master and ship-owner, I take direct issue with him concerning the mercantile marine. He introduces his subject by dating "the era of the modern metal-built steamship in this country from the laying of the keel of the George W. Clide—about 1869." At the very start he is in error. The first iron steamship built in the United States was the Bangor, constructed by Harlan & Hollingsworth, in 1844; and it is singular that, while the twin screw is generally looked upon as a modern invention, the Bangor was successfully fitted therewith, and made a creditable speed of eleven and a half knots. She was owned by the Boston & Bangor line, the superintendent of which has kindly sent me this note in answer to my inquiries:

> The Bangor was the first iron steamship ever built in America. She was built at Wilmington, Del., in 1844, by Betts, Harlan & Hollingsworth, and was a twin-screw boat of two hundred and fifty tons, old measurement, rigged as a three-masted schooner. She was constructed expressly to run between Boston and Bangor. Her history, however, covers a great deal more than that circumscribed course.
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> On her way north from Wilmington, the Bangor called at New York to land passengers, and attracted a great deal of attention there, as she also did in Boston, the beauty of her hull being much admired by nautical experts. She had berths for eighty

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passengers, and an under-deck carrying-capacity of one thousand barrels. Unfortunately, on her second trip the Bangor took fire, and was run ashore on Long island, Penobscot bay, where she was burned,—all except the iron shell of her hull. The passengers got ashore all right, with just what they stood in; but cargo and everything else went up in smoke. The steamer was afterward rebuilt at Bucksport, sold to the government, and went out to Mexico during the war between that country and the United States, her name having been changed to Scourge.

Between that time and the epoch fixed by Mr. Nixon as the beginning, this firm also built nearly one hundred iron vessels, many of which were adapted to coastwise navigation, to say nothing of those built by other firms. Still, although iron ship-building had long been successful in Great Britain, Americans, as a rule, could not be made to believe in the principle until about thirteen years after the launching of the Bangor. It was difficult to disabuse them of the idea that Noah, who built his ark of wood, was not more worthy of imitation than Harlan & Hollingsworth, who had succeeded in "floating a tea-kettle." The Pacific Mail Steamship Company went on as before, building their old-fashioned wooden-side side-wheelers. When I asked Mr. Johnson, the secretary of the company, why they did so, he replied: "Well, we are not yet satisfied that iron is better than wood, especially in the Pacific ocean, where there is a certain quality in the water that eats it up with rust." Thus the new industry dallied along with no appreciable results until 1857, when there was a sudden revival on an increasingly large scale. Harrison Loring & Co., of South Boston, then took the front rank among the American iron-ship-builders. In that year they built the Sestos, of 500 tons; in 1858–9, the Contest, of 500 tons; in 1859–60, the South Carolina and Massachusetts, each of 1,250 tons; and in 1860–61 the Merrimac and Mississippi, each of 2,000 tons,—all sea-going screw-steamers. The Pembroke, 250 tons, was built early in the sixties by another Boston firm, and sent out to China by R. B. Forbes to be employed in the coasting trade there. But even these successes do not appear to have been sufficiently convincing. As late as 1870, when the United States congress at length discovered that the national carrying-trade had been dwindling away in the fifteen years then just past, it appointed the first investigating committee to discover the cause, if possible. Mr. John Lynch, of Maine, was its chairman. That intelligent wooden-head submitted a report to the effect that American "commerce," as he called the carrying-trade, had been run off the ocean because its wooden ships had been destroyed in the United States civil war, or sold to parties abroad, and England had replaced them by her iron ships. To surmount this difficulty, he asked for a large bounty for the purpose of building more wooden ships to drive these British iron ships from the seas in their turn. Mr. Lynch was

not alone in entertaining the idea that the decadence of the American carrying-trade was entirely owing to that war, not considering that, if these wooden vessels had been of any real value, they would have been immediately replaced by their owners as soon as they had collected their insurance. The facts of the case, strange as it may seem, demonstrate that, so far as the tonnage owned at the beginning of the war was concerned, riddance of it was a positive benefit. It was a period during which iron had effectually proven its superiority to wood, and the older American vessels were either sold to underwriters, or to shippers of other nationalities, in whose docks they finally rotted. America received $15,000,000 for the Alabama claims, and was overpaid. After the war came to an end, the United States should have replaced its useless and departed wooden hulks with iron vessels, buying them for a time until the ship-builders of the country had learned to build them, as they would readily have done, just as the builders of non-prohibited railroad engines had already succeeded in establishing their home market. That was the mistake in the first place, at the instance of protected domestic ship-builders, and, at the same dictum, it has been the mistake to this day. Had that policy been adopted in the outset, as it was in Germany, the United States, like Germany, would now be building its own ships, and the free-ship advocates would not still have occasion to persevere in their arguments.

Nevertheless the war was a setback to American ship-building and the carrying-trade. During its existence, and for a long time afterward, the country was burdened by a necessarily high tariff for revenue, and by an unnecessarily high tariff for protection, both so operating together that domestic iron-ship-building, which had just taken so fair a start, was for the time being effectually squelched. When peace came, it was at first impossible to build iron ships as cheaply as they had been built before the war. There was left one of three things to do: to pay a bounty to ship-builders, to buy ships, or to be without them. As to the first, it may be said that ship-builders are no more entitled to bounties at the public's expense than are other mechanics whose business is depressed. Moreover, it has been abundantly proven that bounties and high duties are sedatives paralyzing the energies of their recipients, whereas, the nearer the approach to free trade, the more stimulus is given to emulation. Each congress since the time of Mr. Lynch, Republican as well as Democratic, has shown its wisdom in refusing to confer favors of this kind, although one came near to stultifying itself in that way, and was prevented from doing so only by the efforts of Hon. John W. Candler, a Republican ship-owner from Boston, whose knowledge of the business was convincing to his fellow-members from the interior.

Mr. Nixon says: "About all the American statesmen attempted for American ship-building during this fitful epoch was the introduction of free-ship bills in congress." On the contrary, all that these supposed statesmen attempted to do in all these years was to pass some kind of a subsidy or bounty bill for the further protection of American ship-builders. Not only were such bills reported, but they were frequently discussed in both houses, fortunately without success, notwithstanding all the money that was spent upon them. Genuine free-ship bills have never been even reported in either house. A *quasi* free-ship bill was reported by Mr. Fithian in the last Democratic congress. Its purpose was merely to admit to American registry, for service in the foreign carrying-trade only, such vessels—and there are many of them—as are indirectly owned by American citizens. Its provisions were worthless, for nothing would have been gained by the change of flag. Still, the influence of a noted American ship-builder prevented even discussion of this measure. Of the three different propositions for restoring the national carrying-trade, the country was not foolish enough to adopt the first, or wise enough to adopt the second, but, not being able to agree upon either, it has accepted the third in not additionally protecting ship-builders by giving them anything beyond the absolute monopoly they have always had, while, in refusing to further the interest of ship-owners by permitting them to own ships on the same terms as their competitors, the United States has voluntarily thrown an immense carrying-trade into the hands of other nations, stuffing into their pockets thousands of millions of dollars that might have been earned by its own people, and allowing them to raise sailors for their navies, while its native countrymen were obliged to seek employment in clam-digging or on the shoemaker's bench. Having disposed of Mr. Nixon's assertion that the era of the first modern metal-built steamship built in this country dates from 1869, and discussed some other questions following this proposition, I will barely refer to his worn-out argument that England established and maintains her ship-building by subsidies. That is simply a repetition of what Mr. David A. Wells has concisely characterized as "a historic lie." Not two per cent. of her merchant fleet have ever received a subsidy or a subvention, and, when they have received them, the government always got its *quid pro quo*. These subsidies were as available for ships built in Mr. Nixon's or Mr. Cramp's yard as for those built in the ship-yards on the Clyde. They had nothing whatever to do with the furtherance of national ship-building.

We now come to the closing paragraphs of the article under consideration.

Causes already delineated have promoted the ship-building industry to a point

where, quality of output being duly considered, it can compete on even terms with any and all comers. The disparity in first cost between American- and British-built ships of like classes has been so nearly eliminated by our recent phenomenal progress in the art, notwithstanding our higher wages, that it has ceased to be an important factor in the situation. Merchant and steamship companies can now, all things considered, procure American-built ships as economically as ships of English build. This, of course, refers to the higher classifications. Hence the American ship-builder is ready to do his share towards resurrection of our sea-going merchant marine on the most favorable footing. But, as yet, the disparity between this country and England in the matter of cost of operating ships of like classes exists in full force,—in sufficient force to be practically prohibitory. For this reason, and for this alone, the facilities of the American ship-builder are not to any considerable extent, or with any encouraging continuity, called into requisition by the American ship-owner. This is not because the American ship-owner does not desire new ships, but because, under existing conditions of competition with rivals receiving substantial aid from their respective countries, he could not operate them profitably if he had them.

Thus the reader will perceive that, no matter from what point of view the situation is surveyed, or no matter at what admitted point of fact the train of reasoning may begin, the conclusion arrived at is always the same,—namely, that the future of American ship-building in any large sense depends upon the future of American traffic over sea; and that the future of over-sea traffic is wholly in the hands of our national statecraft and diplomacy.

The "causes already delineated" are the demands of the navy for ship-yards which would not otherwise have been put in operation,—the very causes to which he erroneously attributes the first impetus to British iron-ship-building for the merchant marine. Herein is another of his mistakes. Long before an admiralty order was given to the British iron ship-builders they had turned out for their own countrymen, and for all people excepting Americans, who still adhered to their wooden ships and restrictive navigation laws, iron steamships and sailing ships that had appropriated the carrying-trade of the world while we were looking on. It was because they had these magnificent plants already that the government availed itself of them. The condition of things in the two countries is precisely reversed. In Great Britain the government makes use of what were from the beginning merchant-ship-yards, and which would survive and flourish without the aid of the State. In America, it seems, merchant ships can be built only in government shipyards, and, in order to build more merchantmen, the country must continue to build ships for the navy, whether they are needed or not, to make these ship-yards remunerative. However that may be, Mr. Nixon insists that American ships can be built as cheaply as English ships, especially "those of higher classifications." In the latter assumption he is more nearly correct than in his general statements; but he is not correct in either. It was not long ago that the steamship China was built for the Pacific Mail Steamship Company. Her net tonnage was 2,400 tons. Mr. Gould, the president of the company, showed me the specifications that were laid before the Ameri-

can ship-building firms. The lowest bid he could get from them was $168,000 above that of the Scottish firm which finally contracted for her. She is surely a ship of the higher classification—far superior to any other on the line. It is cheaper to own her under the British flag without a subsidy than under the American flag with one.

Mr. Chamberlain, the late commissioner of navigation, estimates the average difference in cost between British and American steel vessels at 25 per cent.—in favor of the former. Mr. Dodsworth, the editor of the New York *Journal of Commerce*, has a reputation as a statistician equal to that of David A. Wells or Edward Atkinson, and has made a special study of this question. He tells me that Mr. Chamberlain has underestimated the average. He admits that for passenger ships it may be even less, because American cabinet-makers and upholsterers are greater adepts in their arts than are British mechanics in the same line, and use machinery more extensively for that purpose. On the other hand, it is not generally realized by those who discuss the matter that the most profitable part of the ocean carrying trade is prosecuted by "tramps," roughly, though strongly, built, with no cabin accommodations beyond those required by the captain and officers. He estimates the cost of some of this class of vessels as 40 per cent. less than that for which American ship-builders are willing to supply them. Then there are intermediate classes of ships, built mostly for freight, but with limited passenger accommodations, on which the difference of cost should be calculated accordingly. I am inclined to give credit to such testimony as this, which fully corresponds with all other disinterested statements that I have been able to collect. It is not true that "the American ship-builder is ready to do his share towards the resurrection of our sea-going marine on the most profitable footing." Were it so, he would prove by actual demonstration that Mr. Chamberlain and Mr. Dodsworth are incorrect in their calculations. Nor is it true that "the disparity between this country and England in the matter of operating ships of like classes exists in full force—in sufficient force to be practically prohibitory," and that "for this reason, and for this alone, the facilities of the American ship-builder are not to any considerable extent, or with any encouraging continuity, called into requisition by the American ship-owners." To say nothing of hundreds of "tramps" owned and commanded by Americans, but forced by the laws of their country to sail under foreign flags, several of the large cargo and passenger ships of what is called the International or American line are likewise thus owned, and they are all profitably sailed. Otherwise they would not exist. Bear in mind that such vessels are debarred from the coasting trade, which sometimes might be very convenient for them. Would it cost any more to sail them if

they were built of American instead of British iron, and if they had American instead of British ensigns at their peaks? If the cost of building were the same, would not their owners have them built in the United States, in view of the great advantage they would derive from liberty to participate in the coasting trade? I quite agree with Mr. Nixon that "the future of over-sea traffic is wholly in the hands of our national statecraft and diplomacy." It is unfortunately true, as it is true that it has been so in all the years back; and it is still more unfortunately true that American national statecraft and diplomacy have been, and still are, controlled by the selfish policy of individual ship-builders.

In conclusion, although I have said enough already to indicate my belief that free ships are the only means for promoting ship-owning and ship-building, I have never advocated their admission to the flag under any conditions that would imperil the general interests of the coasting trade.

From the beginning of the discussion when I appeared before the Lynch committee in 1870 (although the chairman refused to incorporate in his report any remarks made by free-ship advocates) my proposition has been simply this: "Full American registers, for all vessels of over three thousand tons, wherever built."

This would not give all that might be desired, but, while it would not interfere with the interests of domestic ship-builders, but, on the contrary, would bring repairing business to their yards, it would permit the United States to engage in the great trans-atlantic traffic on equal terms with other nations, and, by gradually leading to the imitation and reproduction of such ships at home, would eventually bring down the cost of all ship-building, so that the great object of equalizing it with that of foreign countries would be accomplished.

I have no doubt that, if congress had listened to this suggestion twenty-seven years ago, the American mercantile marine would by this time have nearly equalled in tonnage that of Great Britain, and that the United States would have saved thousands of millions of dollars that have been needlessly paid to European ship-owners in freight-money.

"It is never too late to mend." Let the United States now do what it should have done long ago.

THE PARIS FIRE AND THE BUILDING OF TEMPORARY STRUCTURES.

By H. Heathcote Statham.

THE terrible disaster in the Rue Jean-Goujon at Paris is of a nature to set us all thinking as to the dangers that we run from the combination of fire and panic in crowded buildings, and the best means of rendering such disasters impossible in the future. It is true that in a certain sense the fire was an exceptional one in its circumstances and in regard to the nature of the building in which it occurred. The construction of the building (if it can be called a building) was such as to render it almost as good a subject for conflagration as if it had been specially prepared for that purpose; and its plan and arrangement, and the nature of the crowd collected in it, afforded, unhappily, the best, or worst, possible conditions for a panic. In these respects the catastrophe may be considered to have been a much less typical one than the ordinary run of theater and public-ball conflagrations, and it might be argued that for that reason it is less instructive as a warning, or as an event from which to deduce practical conclusions; which would be true in a sense. But in another sense the exceptional circumstances of the fire give it a special significance. It forms one of those terrible surprises that fire is always springing upon us as a reminder that we have overlooked a forgotten something. We have in recent days spent a good deal of trouble in rendering our permanent buildings fire-resisting, and in providing adequate means of exit; and we are prone to sit down and reflect that we have done the work well, and, as far as human forethought can provide, have exorcised the fire-demon. Suddenly he starts up in a new form, and reads us the tragic, but not unneeded, lesson: "You have forgotton your temporary structures!"

It is to be hoped, certainly, that not many even among temporary structures are so laid out for fire and panic to do their worst as was the ill-fated bazaar booth at Paris. Yet we cannot be sure even of that. When temporary structures are erected for public enjoyment or public business, as long as all goes right little attention is paid to the construction or materials employed; people have plenty else to think about. Yet there may have been scores of temporary erections set up, and crowded for a day, or for a few days, which, if accidentally set on fire, would have led to almost as dreadful results as those which have horrified us at Paris. They have escaped, and nothing more has been

thought about them or the terrible dangers which lurked in them. At last a catastrophe has come, and people are as astonished and horrified as if no such thing were to be expected.

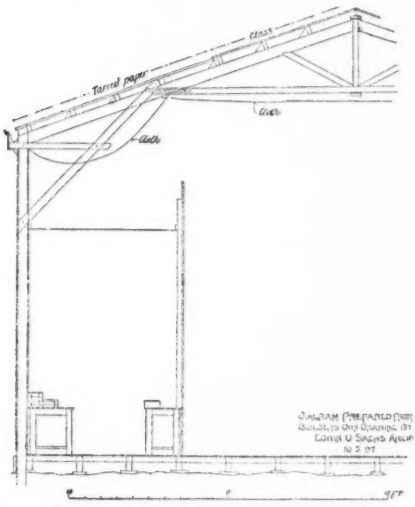


FIG. 1. SECTION OF THE PARIS BAZAAR.

The section (Fig. 1) of the Paris bazaar will show, however, conclusively enough, that nothing was wanting to prepare for a conflagration. The building was erected, under apparently no superior supervision, by a Paris firm of contractors who had been largely employed in the provision of temporary decorations in the streets for special *fêtes*, and who therefore must have acquired a habit of erecting flimsy structures. It is stated that they were anxious, for charitable reasons, to put the building up as cheaply as possible; or (more probably) they were urged to do this by the promoters of the undertaking, who did not wish to devote more money than necessary to a portion of the project which would produce on return. Under these circumstances, naturally, no extra expense was incurred in seeking for special and noninflammable materials. That which was cheapest and most readily procured was used. The roof was covered with tarred paper; and beneath the glazed skylights a cloth velarium was loosely draped, with plenty of air-space between it and the roof. The walls were formed of wooden posts with very thin boarding (about half-inch) nailed on

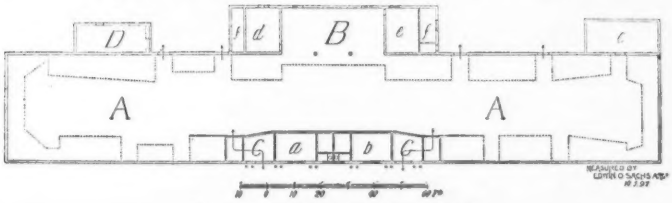


FIG. 2. PLAN OF THE PARIS BAZAAR.

them. It would be hardly possible to erect anything which would more readily catch and spread fire.

The plan (Fig. 2) shows how completely the building was arranged so as to form a trap in case of any panic and hurried attempt at escape. The following are the references to the letters on the plan:

A—Gallery.
B—Buffet.
C—Lobbies in connection with main entrances.
D—Cinematographe room.

a—office.
b—cloak-room.
c—store.
d—buffet-store.
e—office.
f—stores.

The principal doors, at C, are arranged in the worst possible way for a hurried exit, two turns having to be made to get out (the object of this having been to exclude draughts). The dotted lines represent the stalls and counters. The two ends of the enclosure are *cul-de-sacs*. The fire began in the cinematographe room, D, and almost immediately spread into the main enclosure, being greatly assisted in this by the velarium, which caught fire and began to blaze at once. The crowd naturally fled toward that part of the building which, in the plan here given, lies at the right. Those who made for the main entrances naturally pressed toward the right-hand one (on the plan), the one furthest from the origin of the fire. Many rushed towards the extreme end of the enclosure, and numbers thronged and struggled through the cloak-room door, taking it in their panic for an exit. The two extra doors, between that and the buffet (marked with arrows on the plan), were apparently unknown to them, and were perhaps concealed to some extent by articles on sale; at all events, no one seems to have known of them. The melted tar from the roof—the glass having broken with the heat—dropped, and pieces of the burning velarium also, setting fire to the dresses of the ladies who composed the main portion of the crowd. Thus all things concurred towards the rapid spread of the fire and the multiplication of circumstances calculated to increase the general terror and confusion. The fact that nearly all the crowd were women told against them in a double sense. Their dresses more easily caught fire; and they had not sufficient strength to break through the side walls, which, I am assured by an architect who had examined the remains of the structure, were so flimsy that a few resolute and strong men could easily have broken through them at any part. Probably both men and women were too dazed with fright even to think of such a thing. It is sometimes said, and said very truly, that the people in a building would always have time to escape after an alarm of fire, if they could only keep their

heads and go out in an orderly and systematic manner. But in the present case there was hardly time for that, if the presence of mind had been there to organize the retreat. So inflammable was the building in every direction that the whole thing seems to have been practically over in a few minutes.

Such are the main circumstances of this heart-rending disaster, one of the greatest public calamities that has overtaken any modern city in recent times. And now what are we to say as to the lesson to be drawn from it? Confining ourselves, in the first place, to the immediate subject,—that of temporary structures,—it seems imperative that all such structures should be placed under official control and inspection, just as much as the most important permanent building. The temporary building may have to be in use for only a few days; it may in some cases be in use for only one day; but on that one day the disaster may arise, and the consequences may be as tragical as in the case of the burning of a permanent theatre. And the fact is that in most cases temporary structures are much more dangerous than permanent ones; they may be, and commonly are, quite as difficult to get out of, while they are almost certain, as usually constructed, to burn much quicker and have less time for exit. It appears that in Paris any contractor who receives the order may erect such a structure as this bazaar building, of the most inflammable materials he finds it convenient to employ, and on any plan he likes, without rendering himself subject to any official inspection or to any fine for evading regulations. It is clear that this must be so, because every one who knows the French passion for red tape and for enforcing regulations, where they exist, even without necessity and to the great inconvenience of individuals, will know that no French official would have let pass the opportunity for pouncing on a builder who had evaded any legal conditions. The first thing the French will have to do, and no doubt will do, will be to pass enactments regulating the construction of temporary erections and subjecting them to official inspection. It is sad that they should have needed so terrible a fatality to rouse them to a perception of the importance of such regulaions; but it can hardly be supposed that they will be any longer blind to it.

London is not so behindhand. Section 84 of the London building act provides that no person shall set up any wooden structure (except hoardings not exceeding twelve feet in height) without a special license from the county council; and, while there are no special structural conditions laid down (which would be hardly possible for a class of structures likely to be varied and abnormal in character), there is no doubt that the architect of the council would exercise a considerable discretion as to the buildings which he would warrant, especially if for

any public use which would lead to their being crowded with people; and I think it may safely be assumed that such an erection as that in the Rue Jean-Goujon would not have been allowed in London for such a purpose. What degree of control of such structures is provided for in American State or city building laws I am not aware.

Assuming the existence of official control over temporary structures, what are to be its demands? We cannot demand the same monumental structure of brick, stone, or terra-cotta which is required by the usual building-act rules (in England, at all events) for public buildings; they would then cease to be temporary structures. But we ought to require that they should be constructed of fire resisting materials; of materials which, if not uninflammable, at least are such as to catch fire with difficulty and burn slowly. All such stuff as the "tarred paper" which covered the Paris building would, of course, be rigidly prohibited. Wood in thin sections should be prohibited; where a thin filling is required between uprights, there are plenty of incumbustible substances to be had now, in the nature of fibrous plaster slabs, concrete slabs, etc., which can supply the place of the match-boarding without presenting, like that, an expanse of fuel. Whether iron should be insisted on for the main upright supports is perhaps a question. It is somewhat difficult to treat vertical iron supports as a part of a temporary structure; they mean a good deal of additional expense, and a more elaborate foundation than a timber upright requires; and it must be remembered that a hard-wood post of substantial thickness is really more fire-resisting, as facts have proved over and over again, than an iron column; it may catch fire to a certain extent, while the iron column or standard will not; but it will only char slowly, and it will retain the greater portion of its strength long after a wrought-iron or cast-iron column will have bent and twisted with the heat, and let the floor or roof down. On the other hand, a light iron roof, with the principal connected by a shoe with the head of the hard-wood upright, would be preferable to a timber-framed roof, which must necessarily include a certain amount of rather light wood, likely to add to a conflagration. Any hangings or cloths used in the decoration or covering of any portion of the structure should be made of non-inflammable materials, of which there is now a considerable choice; the expense may be a little greater in the first instance, but what is that compared with security from fire? If the promoters of a temporary building are unwilling to go to this expense, it should be the business of the official authority to compel them to do so.

In addition to the question of material comes the question of plan and arrangement of exits. In a structure of a temporary character it is generally very easy to arrange plenty of exits, it being usually a

structure of very simple plan and with few or no accessory apartments. In more complicated permanent structures the provision of a sufficient number of emergency exits is often rendered somewhat difficult by the fact that the main apartment—as is often the case in a town hall—is surrounded by subsidiary rooms and passages which lie in the way of a direct exit. But in a temporary structure there is, in general, none of this complication of plan, and it should be easy to have exits in nearly all directions. What is important is that these exits should be easily recognizable. There is where one of the aggravating causes of the Paris disaster came in. The two exits known to all the people (those at C, Figure 2), and by which they had entered the building, though very suitable as entrances, were hampered as exits by the vestibules and by the right-angled course which had to be taken between the inner and outer doors. The exit doors at the other side (indicated by the arrows) were apparently not known to any one, were not immediately recognizable as doors, and were not marked "exit," as they should have been. But perhaps the worst point of all about the plan of the building was the fact that each end of it was a *cul-de-sac*. When a crowd in a panic flies in a particular direction supposed to be the farthest from the danger, it will always press as far as possible in that direction, and a crowd which has thus thronged up to the end of a building and finds no door there is lost; it cannot move back again in consequence of the pressure of those who are still making for the extremity of the space, having not yet discovered their mistake. Therefore, one of the most fatal features in the plan of the Paris building was these two dead-ends.

There remains the question of interior fitting and furnishing, in which it is sometimes difficult to avoid the aggregation of a considerable amount of inflammable material. In a temporary building in which the floor is at all raised from the ground, it is difficult to have anything else than a wooden floor, unless we are pre-supposing a more monumental form of wall-construction than can generally belong to a temporary building. As regards danger from fire, thick planks laid on the flat, with sufficient supports at intervals, are safer than a joisted floor with a thin boarding laid on the joists; if any cause of fire arises under the floor, the thick planks are much less likely to catch it, and much slower in blazing up, than the ordinary thin flooring boards would be. One has only to consider the case of ground floors, or floors raised two or three feet from the ground with a space under them; for in a temporary structure upper floors are hardly practicable.

There is, lastly, the material collected in the building in connection with the purpose for which it was erected. If it is a building for

some kind of festival or ceremonial, the principal combustible material will be benches and chairs; if it is for a sale, or bazaar, or exhibition of work, we shall have few or none of these, but a great collection of wooden stalls and, probably, combustible textiles; and with these we can do nothing except take precautions not to allow them to catch fire; they are not part of the building, and no legal regulations can touch them.

Having got our temporary structure into a condition offering as great a resistance to fire, or as little liability to it, as can be attained in that class of building, we have then to guard against the causes which lead to the outbreak of fire. These, in almost all cases, are to be traced to one of two forms of carelessness or blundering: it is either the misuse of a lamp, or its overturning; or it is the culpable carelessness of throwing down lighted matches or lighted paper in the building. The latter cause is almost invariably connected with smoking, and so many fires have begun from this cause that in all temporary structures smoking should be strictly prohibited. The means of lighting have been the cause of many fires; a long list of theater fires is traceable to this cause—the overturning of a lamp in one of the actors' dressing-rooms, the catching of a bit of scenery by an inadequately-guarded gas-jet, and so on. The theater-fires which originate behind the scenes (as most theater fires do) may be not improperly classed with fires in temporary structures; since, though the outer enclosing walls are of solid material, the stage itself and its accessories are very much in the condition of a temporary structure, filled with light materials which ought to be rendered uninflammable, but often are not. It is probable that the increasing prevalence of electric lighting, though it has occasionally been the cause of fire, will in the end very much diminish the list of fires arising from the means used for lighting. The Paris fire almost undoubtedly arose in the first instance from some accident with the cinematographe light, but exactly what it was we shall probably never know now.

Besides the temporary buildings which are really temporary,—that is, put up for only a few days or a few weeks, there is a class of what may be called permanent temporary buildings,—that is, buildings erected in a comparatively slight and unmonumental manner, but, owing to circumstances, allowed to remain in existence and in use for an indefinite period. This class of buildings consists mainly of those which are connected with shows, panoramas, and exhibitions of various kinds; structures which will be taken down eventually, but which may remain in use for a year, or two years, or more. These are often more dangerous than the "temporary structure" properly so called;

the people in charge, as well as the audiences, get reckless about them, get used to thinking of them and treating them as solid buildings; and they almost always have hollow and dark corners in them, in which all kinds of rubbish, sometimes inflammable, accumulates. And this remark serves to remind one that, of all things in temporary structures which are to be avoided as danger-traps, are hollow spaces under a boarded framing,—beneath a rising gallery of seats, for instance. One does not know what may be there; and the careless (might one not say criminal?) dropping of a lighted match or bit of paper through some opening in the floor of the seating may set everything in a blaze in an almost incredibly short time. Therefore, in temporary structures avoid all hollow spaces which cannot be easily seen or got at.

The subject of the safety of temporary structures is of great practical importance in these days of international and national exhibitions, where so many elaborate erections are raised which, in general, have the forms of monumental architecture without the power thereof. The subject will probably come home to the minds of American readers, for Chicago has left its mark behind it, and there are likely to be many minor, but still important, exhibitions with similar buildings. It is to be hoped that they will be so constructed and planned as to afford the least possible chance of fire, and, in case of it, to leave the audience time to retreat with safety and in order.

One word on this subject of orderly retreat from a building on fire. It does not apply to the recent Paris fire, where, for a large proportion of those present, even presence of mind would have done nothing, the conflagration being so sudden. But in all cases where the building offers a decent amount of resistance to the fire, there is no doubt that any audience might walk out in a few minutes and in perfect safety, if they would only bear in mind the military principle of preserving a definite order in their movements. To walk, for instance, two and two in line, without hurry but in a regular ordered step, is the way a large body of men can be got through a small door in two or three minutes time, without struggle or confusion. The same system is just as available to get an audience through a theater door in two or three minutes, if only they keep their heads sufficiently to carry it out, and if the cool-headed among them will guide and direct the others. Many lamentable and perfectly unnecessary catastrophes from panic would have been avoided by this simple means.

CHARACTERISTIC AMERICAN METAL MINES.

THE ANACONDA COPPER MINE AND WORKS.

By Titus Ulke.

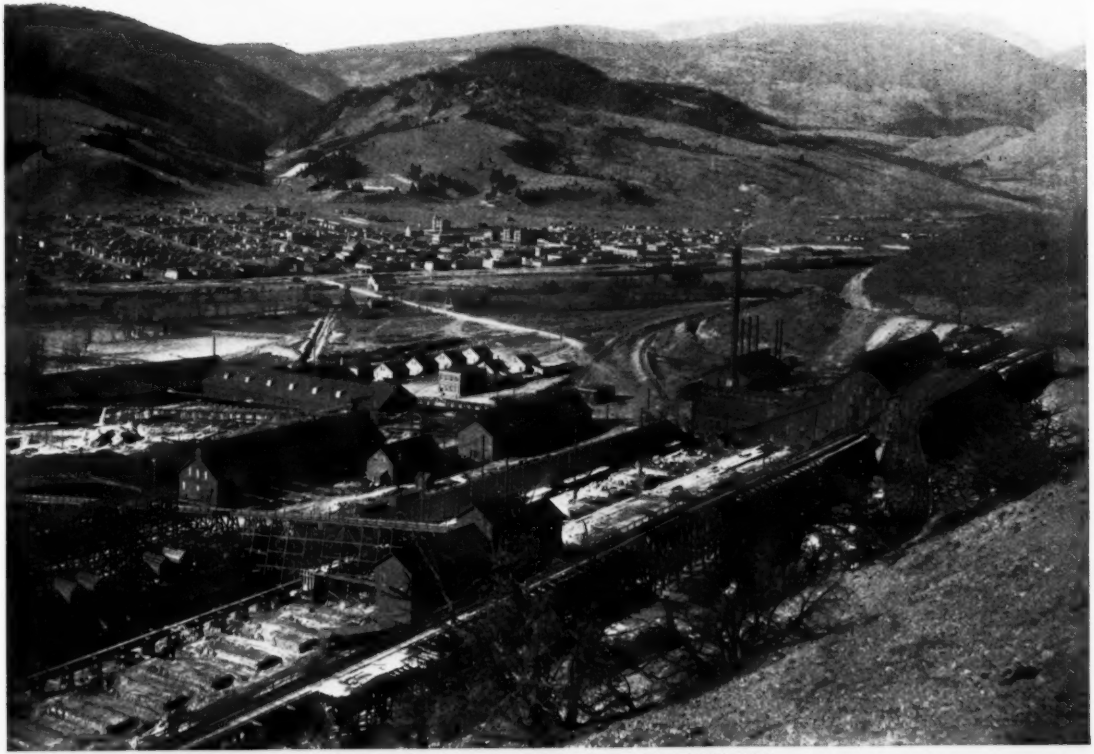
THE famous Anaconda group of mines, located near Butte, Montana, on the western slope of the main divide of the Rocky mountains, is now the largest copper-producer in the world. Last year its output, reduced to metal, was more than one hundred and twenty-five million pounds of copper, and about five and a half million ounces of silver, besides seventeen thousand ounces of gold. Together with the Anaconda reduction works, it furnishes an admirable example of the highest development of mining and metallurgical practice, and of a far-seeing and wise business management.

The discovery of placer gold in the valleys near Butte in the sixties first attracted attention to this district. When the placers were worked out, prospectors turned their attention to silver mining, and soon discovered the great wide lode on which the Anaconda was located. Dark red and brown quartz, carrying oxids of iron, horn silver, and gold, with only traces of native copper, and very limited occurrences of copper oxid, formed the outcrop of this lode. The vein was richer on the summit of the hills it intersected than on their flanks and in the valleys.

A number of silver mills were started soon after the above discovery, which profitably treated the oxidized surface ores by the usual method of pan amalgamation. No one then dreamed of the tremendous quantities of copper ore soon to be revealed.

The Anaconda was bought as a silver mine about this time, and preparations were being made to mill the ore, when in 1882 the main shaft, sunk to a depth of about three hundred feet, entered the rich copper zone. This copper, leached out of the first three or four hundred feet (in depth) of the vein, or down to the water-line, had been concentrated in the underlying ore, and had thus produced a zone of rich secondary copper ore two hundred to four hundred feet deep, which contained thrice the normal copper contents of the lode below.

In the decuprified surface ore silver was retained as an insoluble chlorid when the soluble copper was removed. The proportion of silver to copper in the enriched copper zone, which contained an excess of copper, was naturally found to be less than in the unaltered ore beneath. Hence the proportion of silver to copper gradually increased with the depth. No massive carbonates were discovered in the Anaconda, or in the other mines situated on the same lode; but



UPPER WORKS AND ANACONDA, FROM ABOVE HIGH LINE.

PANORAMA OF CARROLL AND THE LOWE WORKS.

the neighboring Gagnon and Parrot mines, in their early days, yielded small quantities of an earthy carbonate of copper, rich in silver. The altered ores of the great lode and of the smaller cross and parallel lodes consisted mainly of a compact purple ore, sometimes carrying considerable native silver, and of soft black sulphurets.

The copper-bearing ores are sulphids (chalcocite, pyrite, bornite, and chalco-pyrite), often grading into each other, and found in a series of strong fissure veins in a basic pre-Cambrian granite, which is almost a diorite in composition. The veins form a system of more or less parallel fractures, which originally afforded channels for the copper-bearing solutions, from which the ores were evidently deposited in

GENERAL VIEW OF THE LOWER WORKS.

the interstices and as a replacement of the minerals composing the granite. A later eruption of porphyry (rhyolite), cutting through the granite, appears to have influenced the ore deposition.

The lodes generally have an east and west strike, and an average dip of some twelve degrees to the south from the vertical, though in places this becomes as much as forty-five degrees. The distribution of the ore is very irregular, extensive bodies being frequently found on breaking through what appears to be a well-defined wall. Frequently there is no definite line between the vein and the adjacent country rock. The ore is usually found in chutes, many of which extend several hundred feet along the strike before pinching out.

PANORAMA OF ANACONDA AND THE SMELTERS.

Their depth is frequently even greater than their length, though they are sometimes broken by small faults. The veins are rarely banded, and vary in size from a few inches of compact ore up to a hundred feet or more, as in the main Anaconda shaft. Twelve feet may be regarded as the ordinary width, though a large proportion of the ore raised comes from stopes thirty or forty feet wide.

The gangue rock is usually a decomposed, coarse-grained granite. Besides copper glance, iron pyrite is usually present in considerable amount, but it carries little copper or silver.

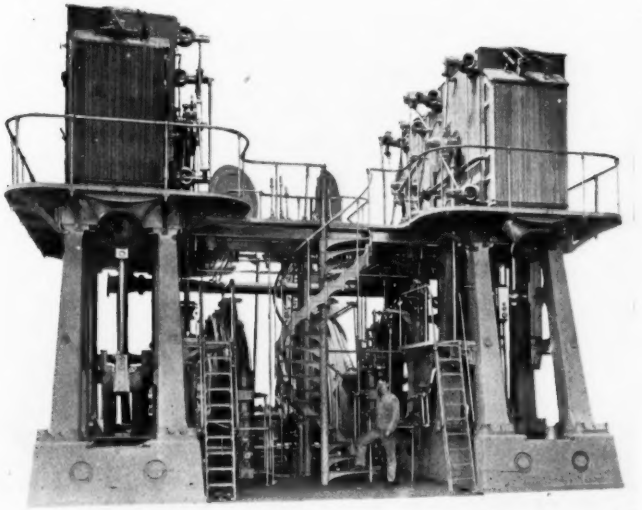
At a depth exceeding thirteen hundred feet, there is no sign of any weakening or giving out of the copper lodes; so that the present enormous output can be maintained, it is claimed, for at least ten years longer. In 1895 the copper output of Butte was about 195,000,000 pounds of fine copper, of which the Anaconda contributed considerably more than half. It seems hardly credible that this tremendous production came from a little granitic area not over two miles long by one mile wide.

The ore raised from the mines of the Anaconda Copper Mining Company, including those of the Chambers syndicate, was formerly much richer than at present, and now averages only 6½ per cent. of copper and 7 ounces of silver per ton. There is a loss of about 18 per cent. in concentration and nearly 5 per cent. in smelting and refining, which further reduces the yield of the ore to about 5 per cent. of copper and 5 ounces of silver. However, notwithstanding this great decline in percentage and value of the ore treated (which, to be sure,

has resulted partly from the ability to work lower-grade ores to advantage), the Anaconda mines are making more profit to-day from a six-per-cent. ore than formerly from an ore twice as rich. This results from the consolidation of mining properties, and from the astounding and radical improvements in the metallurgical treatment of the ore. The rich surface ores of the Butte district have furnished the capital needed to design and construct the improved plants, and to gain the experience necessary for treating the lower-grade ores at a profit.

The shaft house of the Anaconda mine crowns the summit of a ridge near Butte, so that there is ample dumping-ground for whatever waste rock it may be necessary to hoist. But little waste is raised to the surface, however, as it is a handy material for filling the large cavities left by the wide stopes, which can be but temporarily held open by even the best timbering.

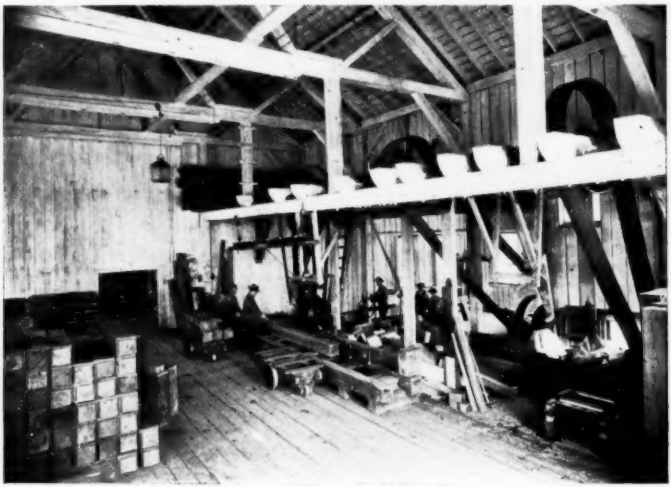
The shaft, which is vertical and now over fourteen hundred feet deep, comprises two hoisting compartments and one pump-way. It is about 9 feet by 18 feet in the clear, furnished with wall plates and lined with timber 12 inches by 12, end and counter pieces being 12 inches by 14. This allows two cars to be placed end to end on each deck of the cage. The winding drums are driven by two enormous compound hoisting engines, supplied with steam from a large battery of boilers.



THE HOISTING-ENGINE "MODOC."

Nearly all the timber used in the mine is squared and sawed above ground, so as to reduce to a minimum delay in erecting timber sets in the workings. Levels are driven from the shaft every hundred feet, and a cross-cut twenty-five hundred feet long connects the Anaconda with High Ore Shaft No. 1. Wherever proper appliances have been introduced, natural ventilation alone suffices to keep the air in perfectly good condition. This fact, and the further circumstance that no serious amounts of water have thus far been encountered, considerably enhance the value of the veins.

The method and extent of stoping varies according to the nature of the lodes. As these in many places have no defined walls, the only distinction between veins and country rock is a commercial one, based



FRAMING TIMBER FOR THE MINE.

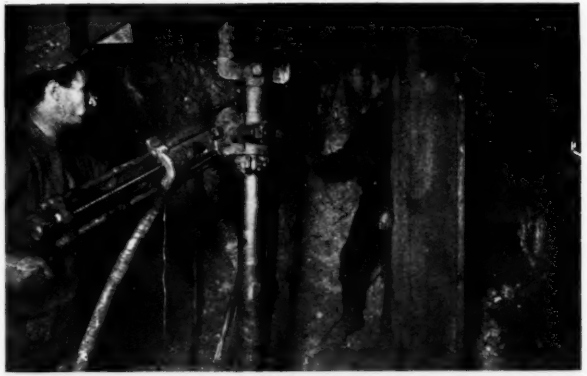
on shipping value. Even in large ore chutes, frequent prospecting by foot and hanging wall cross-cuts must be practised, to develop the small bodies that branch off into the walls at intervals, as well as to furnish waste to fill the large cavities left by the wide stoping.

Square timber sets of the usual construction are used in the workings. It is scarcely necessary to state that stopes of great width do not imply solid ore bodies of equal width.

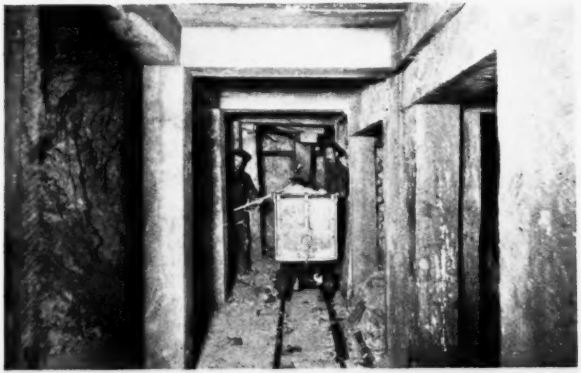
The waste, chiefly decomposed granite, commonly forms twenty-five per cent. of the entire material stoped,—sometimes much more.

The magnitude of the Anaconda Copper Mining Company's operations can be measured when one considers that it spent $2,000,000 in

East sill floor breast. Miners at work.



Drilling the ore.



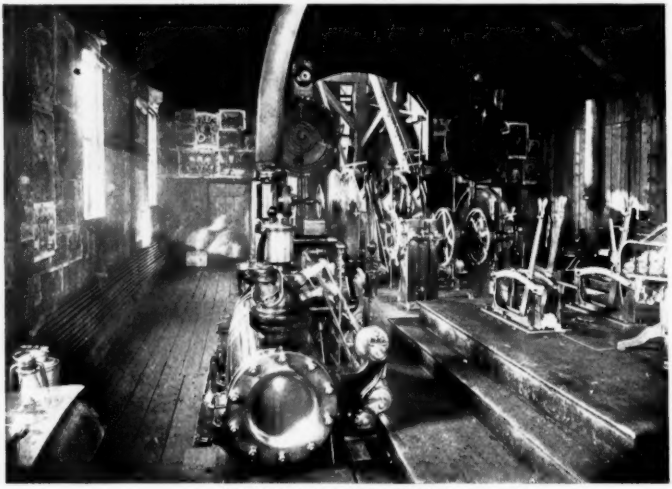
Miners in the breast filling-ore cars.

Station loaded with ore-cars, ready for hoisting.

SCENES FROM THE UNDERGROUND WORKINGS OF THE ANACONDA MINES.

new machinery, hoisting engines, air compressors, etc., during 1896, besides paying a dividend of $2,250,000. The daily output of ore is more than three thousand tons, and the number of employees in and around the mine is two thousand.

The ore is loaded on cars holding about twenty tons each, and is shipped for concentration and reduction to the Anaconda Works, twenty-seven miles from Butte, at Anaconda, and comprising two immense concentrating mills, smelting works, converter plants, and the largest electrolytic refinery in the world. As these works are conveniently located in terraces on the slope of a long hill, near the top of which the railroad passes, the ore can be dumped directly from the cars into enormous bins placed above the two concentrators. High-

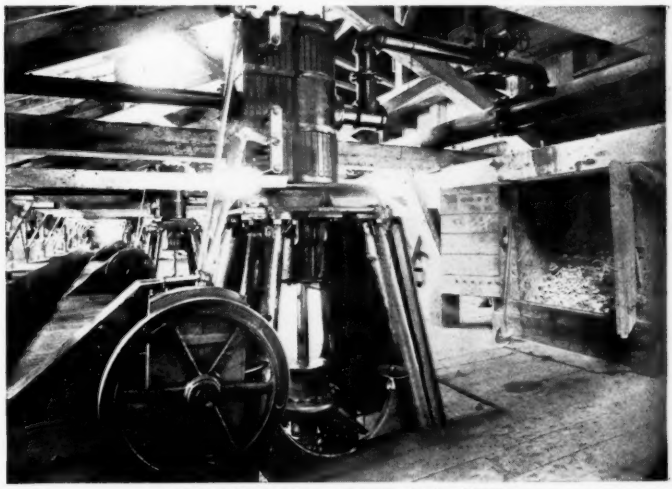


ANOTHER HOISTING ENGINE.

grade ore not requiring concentration is sent directly to the roasting or smelting furnaces.

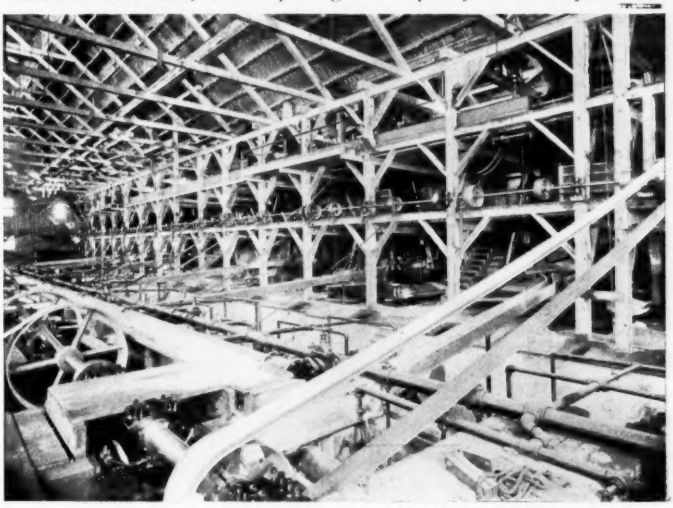
At the Lower Works concentrator the ore from the bins is fed over iron-bar screens called "grizzlies" (with spaces one inch wide between the bars), and then under massive steam stamps. Very large lumps of ore are broken on the grizzlies with sledges. The fines passing through each grizzly are fed into a revolving screen, which sizes the material and drops it into launders, or troughs through which water flows to feed the jigs or piston-machines for separating the barren rock from the ore.

Six steam stamps crush between eighty and ninety-five carloads of

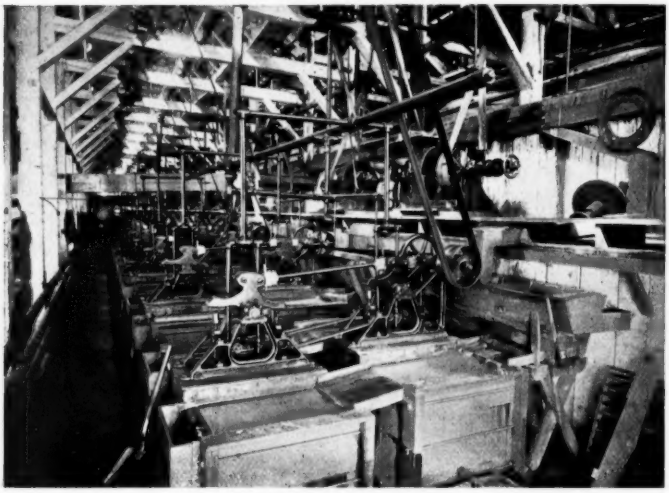


UPPER STAMP FLOOR AT THE UPPER WORKS.

ore of twenty tons each, daily. The crushing capacity of each stamp, therefore, reaches the enormous total of two hundred and eighty to three hundred tons, thus equaling the capacity of seventy to one



PERSPECTIVE VIEW OF STAMP FLOORS, UPPER WORKS.



JIGS AT THE LOWER WORKS.

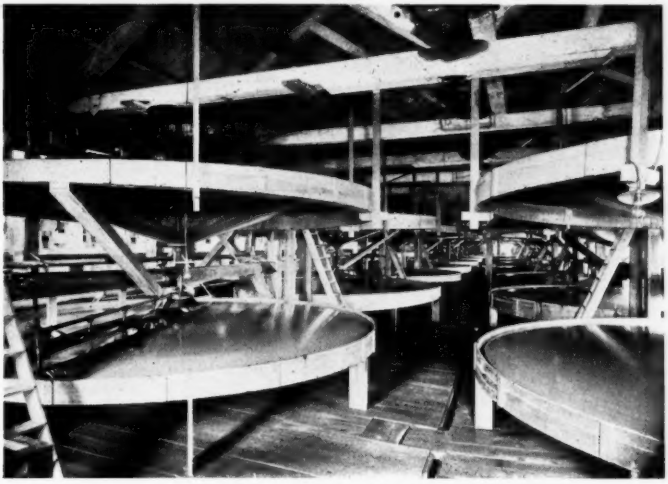
hundred California stamps, or of three hundred Cornish stamps,—certainly a very remarkable fact. The weight of each stamp shoe alone is one quarter of a ton, and of the stem with shoe, etc., one and a

ROUND JIGS, LOWER WORKS.

half tons, the crushing weight being thirty tons. A shoe lasts only three days when the stamp is run to full capacity. The stamped ore is sized in hydraulic separators, and is then fed into Collom jigs.

The order of concentration appears from the fact that the middles, or medium-sized product, from each set of eight Collom jigs go to two round jigs, the middles from these to a pulverizing mill, and the product of the latter to finishing jigs, which separate from the ore the last traces of adhering barren rock. The jigs, of course, are automatic in action. They give little trouble, excepting that caused by the breaking of their springs, which have to be replaced rather frequently.

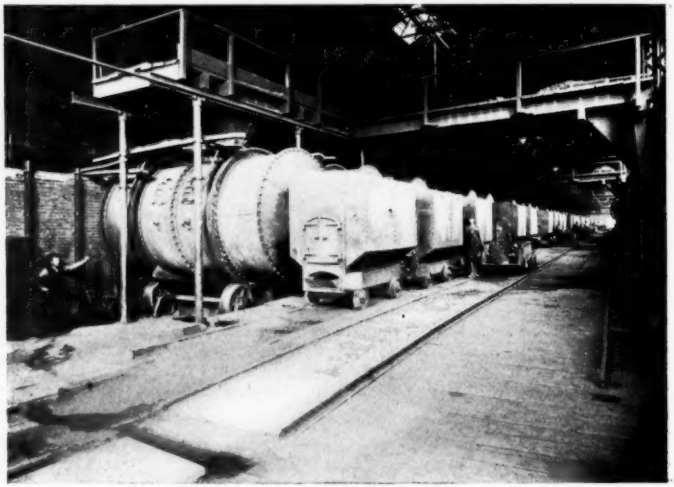
To treat the fines, two sets of eight double-decked round tables



ROUND TABLES, LOWER WORKS.

are employed, together with slime pits. The loss of copper and silver in sliming is heavy, but cannot well be prevented, except by rejecting the otherwise economical steam stamps, and substituting crushing machinery giving a product more uniform in size.

The various concentrates from the jigs, tables, and slime pits are roasted, at a low cost, in batteries of revolving roasters of the Brückner type. The one hundred and fifty-six Brückner furnaces employed at Anaconda are of two sizes, the larger having a cylinder 8½ feet in diameter and 18½ feet long. The front end of the cylinder is contracted to register with the throat of a movable fire-box, while the other end opens into a dust-chamber. The movable fire place is attached to



THE BRÜCKNER ROASTERS, LOWER WORKS.

the cylinder until the charge is ignited, and then removed, and is reattached only to complete the roast.

From 9 to 13 tons of concentrates, inserted in one charge, are roasted every 24 hours, from 36 per cent. of sulphur down to 8 per cent., with a consumption of 1 ton of Rock Spring (Wyoming) lignite. The roasted material is then discharged, red-hot, into hoppers suspended above the matting furnaces. These are reverberatory furnaces capable of smelting or "matting" eight to ten charges of 4.8 tons each (6 cars holding 1,600 pounds of roasted ore) in 24 hours. A little lime is added to each charge, as it reduces the percentage of copper lost in the slag.

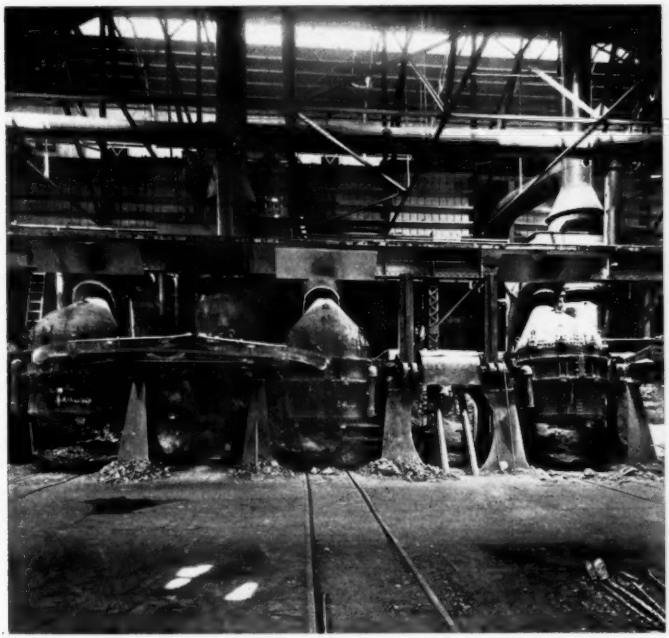
The coal is fed from a hopper into the fire-box, and the ashes are sluiced out of the hopper-shaped ashpit by a current of water. The grates are shaken by an outside handle. The air used for combustion is preheated in a chamber surrounding the stack, passes backward and forward through the main vault under the furnace, and finally reaches the firebox at a temperature of 700° F. By this ingenious preheating arrangement, as much as 46 tons of calcines, or roasted ore, can easily be matted daily on a hearth only 10 × 20 feet in size.

The slag is discharged from a pair of furnaces into a mutual catch-spout, and into a sluice supplied with sufficient water to carry the slag to the dump. As the furnaces are built in a long row, they have a common main dust-chamber, or flue, into which each furnace flue

opens. The main flue discharges into a stack with powerful draft located on the top of the hill.

The product of the reverberatories is a matte, carrying sixty to seventy ounces of silver, and approximating the following composition: 62.5 per cent. of copper, 11.6 per cent. of iron, 0.4 per cent. of lead, 19.2 per cent. of sulphur, and 0.2 per cent. of silica. This matte is sent to the converting house, or bessemer plant, for conversion into bessemer copper. There are two bessemer plants at Anaconda,—one near the Lower Works three miles from Anaconda, and the other and older plant, which we will briefly describe, nearer town.

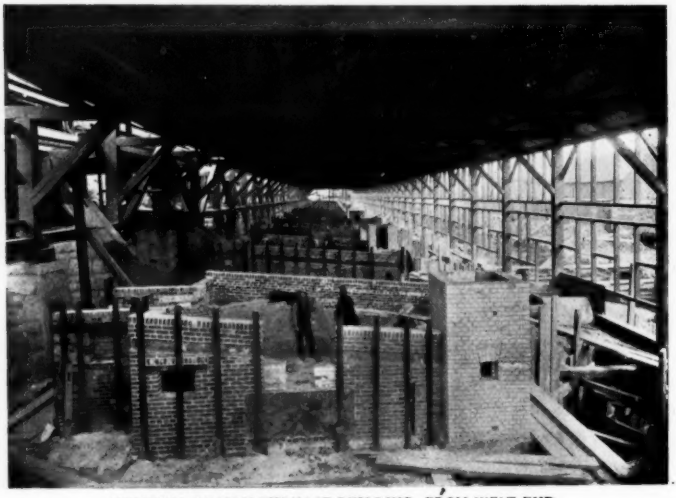
At the time of my inspection (1893) nine converters arranged in a battery were in operation. On a higher level, just above this battery, are three cupola furnaces, into which the matte is charged. The matte, heated to a temperature of about 1,400° F. in the cupola, is tapped out and run through movable troughs lined with fire clay, into the particular converter ready for charging. Each converter holds from one and one half to two and a quarter tons of matte.



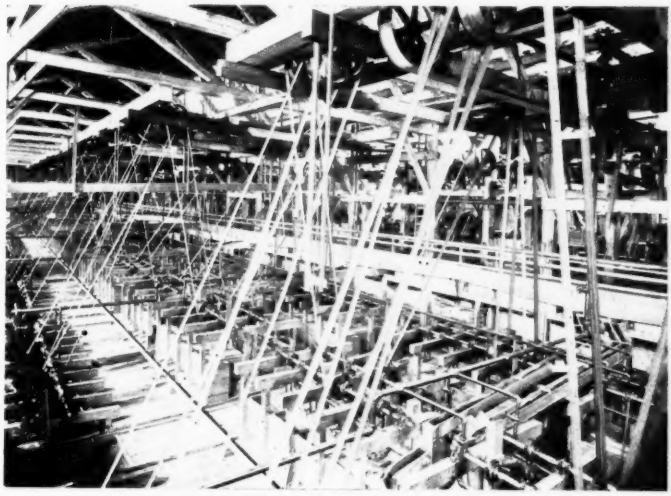
THE CONVERTING ROOM.

After charging the converter, the metal stream from the cupola is stopped, and the converter blast, used to burn off or oxidize the impurities in the copper matte and supplied from blowers through four tuyeres at the back and three at each side of the converter, is turned on. In about twenty-five minutes after charging, the copper in the converter is skimmed. When this operation is finished, a little cold matte is added, and the blast continued until the charge is "cooked," or done. Then the converter is swung over, and its contents—now nearly pure copper—are poured into ingot molds, holding about 220 pounds of copper each. At every conversion or melting, from twelve to twenty-one bars are cast. Generally from one and a half to two hours are consumed between the time of filling and the time of tapping the converter. After twelve hours,—*i. e.*, six charges,—the converter is cooled by running water from a three-inch hose into it, and also over the iron shell, the cooling taking about three hours. Then a man gets inside, and relines the converter with good quartz, to which a little fire-clay is added. This takes from one half to three quarters of an hour. The thickness of the relining averages three inches, so that the total thickness of the lining at new charging is about nine inches.

Before the new bessemer plant was put into blast, two kinds of converters were used: converters with straight tops, in which the bottom plates are easier to repair, because each converter can be entirely



INTERIOR OF NEW FURNACE BUILDING, FROM WEST END.



PERSPECTIVE VIEW OF THE HART JIGS.

revolved on its trunions, and old-style, square converters, with tops curved over, which reduce the danger to workmen from flying pieces of slag. At the new plant larger converters, 10×6 feet in outside height and diameter, having 16 tuyeres, and weighing 11 tons with shell and lining, are employed. A blast pressure of 13 pounds per square inch is used, and 12 blows are made per 24 hours. Although the initial charge is only 3½ tons, a charge of as much as 8½ tons of matte can be treated economically in these new converters.

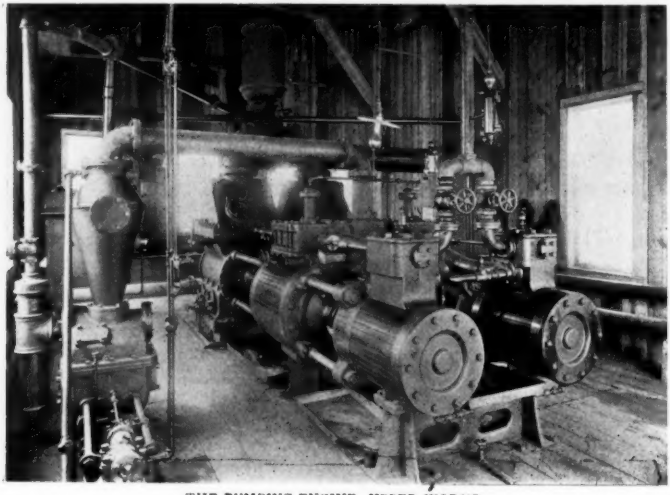
The ingots of bessemer copper, averaging 99 per cent. copper, and 100 ounces of silver per ton, are sent to reverberatory furnaces, to be melted and cast into flat plates (anodes) for electrolytic refining.

The object of electrolytic refining is two fold: first, the making of pure copper of high electrical conductivity; second, the extraction of the gold and silver contained in the crude copper. This work is accomplished at Anaconda in an enormous refinery built on the flat between the Upper and Lower Works.

Although the Anaconda refinery is almost large enough to treat all the converter copper produced at the Anaconda works,—*i. e.*, nearly 170 tons daily,—contracts have recently been renewed with the Baltimore Works whereby they will continue to refine one-half of the total Anaconda converter copper output, undoubtedly because refining costs less at Baltimore, where wages are only half as high as at Anaconda, and because of the proximity of Baltimore to the chief market.

BOILER ROOM, LOWER WORKS.

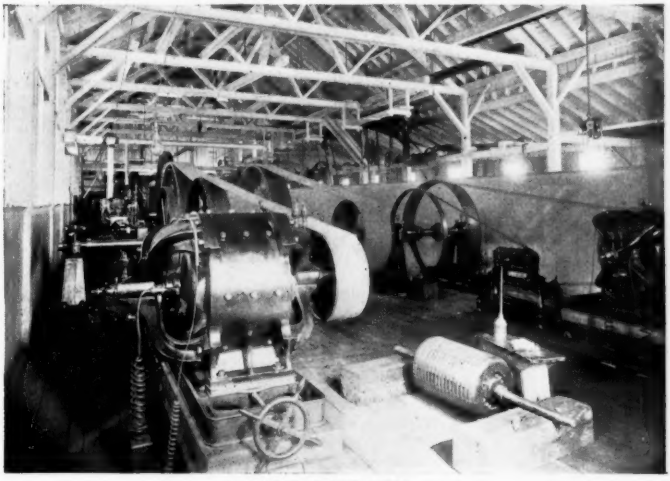
The two sections of the Anaconda electrolytic works are separated by a distance of one hundred feet, for security in case of fire. The buildings, framed in wood covered with corrugated iron, occupy a



THE PUMPING ENGINE, UPPER WORKS.

space of more than 14,000 square yards. The boiler house is two hundred feet, and the silver mill three hundred feet, from the refinery. A part of the following description of the power plant is taken from the *Engineering and Mining Journal.*

The new boiler house contains three sets of two Heine boilers each, having altogether an evaporating capacity of 62,200 pounds of water per hour. Another set of two boilers serves as a reserve. All the boilers are connected by a large iron flue, which takes the smoke and gases to a Green feed-water-heater, from which they are carried to a brick stack one hundred and forty feet high. The steam and feed-water line are common to all the boilers, and the connections are so made as to allow the cutting out of any one of the boilers.



THE DYNAMO ROOM.

Belt coal, containing 20 per cent. or less of ash, is successfully burned by underfed stokers of the American Stoker Company's make.

The ash is conveyed to an elevator by means of water in a sluice, and is finally dumped on the prairie adjoining the boiler-house. The supply of fuel is dumped from cars running in front of the boiler-house into large bins, and from there a bucket elevator dumps it into the supply-bins hanging in front of the boilers. From these bins the coal continuously sinks to the grate hoppers, and is then taken by the grates automatically.

The feed-water is handled by two large Knowles pumps, each alone of sufficient capacity to supply all the boilers. The water is taken

from the hot well of the condenser, and delivered by the pumps through the Green heater to the boilers, acquiring on its way a temperature of about 200° F.

The service of the boiler-house is performed by twelve men,—*i. e.*, two firemen, two helpers, and two fuel passers on each shift, under the supervision of the master mechanic and foreman of the refinery.

The power-house contains one 800 h. p. Corliss engine, one Westinghouse compound engine of 400 h. p., and two triple-expansion engines of 900 h. p. each, making a total of 3,000 h. p. The Corliss engine consumes 30 pounds of water per h. p., and the triple-expansion engines only 15 pounds.

THE MACHINE SHOP.

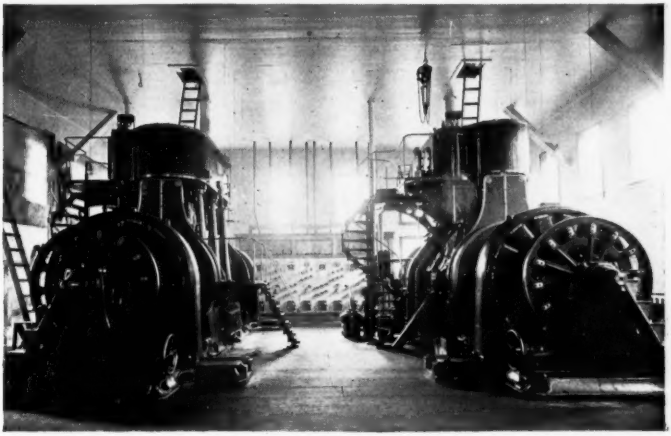
The electric current for the electrolytic work is supplied by seven Westinghouse generators, two being of 220 k. w. capacity and belt-driven, and five being of 270 k. w. capacity, four of which are directly connected to the triple-expansion engines. This gives a total current of 1,790 k. w., corresponding to 2,560 h. p. One generator and engine serves as a reserve unit, and can be switched over to any of the six circuits, in case of an accident or during repairs to any of the six other generators. There are also two dynamos for light and power, consuming together 50 h. p., and a 30-h. p. air compressor, which runs the acid pumps and the condensers for the engines, and consumes 1,500 pounds of steam per hour, equivalent to 50 h. p. Including 1,500 pounds for heating, 51,060 pounds of water evaporated in the

THE COAL HOUSE, FROM ABOVE THE WORKS.

boilers are required to run the above machinery, as against 62,200 pounds,—the maximum capacity of the boiler plant. This amount of power corresponds to a maximum production of 150 tons of electrolytic copper per 24 hours, or to about 17 h. p. daily per ton produced.

The above embraces the power required to manufacture cathodes, to handle and transport the copper, which is done by electric appliances, and to operate the silver mill. As labor here is more expensive than power, work is done by machinery whenever possible.

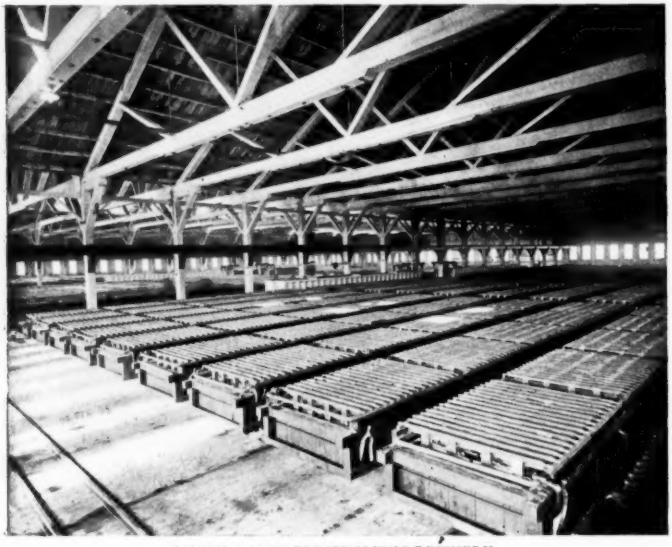
Each of two refinery tank houses occupies 6,500 square yards, and contains 600 tanks. The arrangement of the latter, as well as the usual method of refining, has been so frequently described elsewhere



ENGINE ROOM, DYNAMO, AND RESERVES FOR ELECTROLYTIC REFINERY.

that we do not treat these subjects in this article. We call attention, however, to an ingenious automatic register, employed in the Anaconda refinery, for controlling the refining operation. Every series of five tanks in the refinery is connected to this automatic, commutator-like register. A yoke carrying two brushes slides over its different segments, making one complete turn in an hour, and these brushes bring into contact the terminals of each series of five tanks to indicate the volts on a registering volt-meter. In this way all the tanks are controlled once an hour, and the readings registered on paper automatically. This enables the man in charge to see at a glance the condition of all the tanks in the refinery. He can see at once when any trouble occurs in a tank, and its nature; when it started, and how it developed. He is able to point out to the foreman the tank in question, and this instrument continues to record the time when the man started to correct the trouble, how much time it took him to do it, and also how completely the work was done.

The plates of pure copper, electro-deposited, are sent to the reverberatory plant to be cast into wire-bars. The plates are put into large reverberatory furnaces in the evening, and heated all night, finally to a temperature of 1,800 to 2,000° F. Charcoal is then added to the metal bath, and the little slag appearing is skimmed off. The last



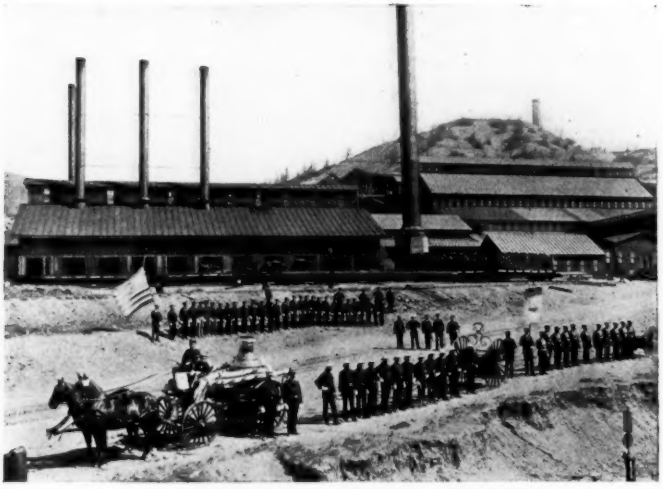
EXTENSION OF ELECTROLYTIC REFINERY.

INTERIOR OF ELEVATOR TANK-HOUSE, UPPER WORKS.

traces of antimony and other impurities in the copper are then removed by "poling,"—*i. e.*, thoroughly stirring up the metal with long birch stems,—after which the copper is poured into suitable wire-bar molds. The bars, which are generally 42 inches by 4 by 4⅜, are sent to wire and rolling mills, to be drawn into copper wire.

The precious metals separated from the copper by the above electrolytic process are refined in the silver mill, and parted by sulphuric acid. Bars of fine gold and ingots of fine silver, which are mostly shipped to England, are thus secured.

In conclusion, we add a few data showing the magnitude of the Anaconda and other mines of Butte City. The total number of men employed at the mines and smelters of the Butte district exceeds 5,000, not including those working in the smelters of the Anaconda Company and of the Boston and Montana Company, comprising at least 2,000 more. The daily output of ore is about 6,000 tons. For the year 1896 the approximate value of the product was $35,000,000, and the profits were more than $6,000,000, divided approximately as follows: Anaconda, $3,000,000; Boston & Montana, $2,000,000; Montana Ore Purchasing Co., Parrot, Colorado, and Clark's properties, more than $1,000,000. In 1894 the Anaconda produced copper to the value of $11,000,000, and made a profit of more than $3,000,000. In 1896 its copper output was 125,000,000 pounds, besides 5,500,000 ounces of silver, and 17,000 ounces of gold. An interest



FIRE COMPANY AT THE UPPER WORKS.

in this property was recently purchased by the Rothschilds, it is known, for $15,000,000, and gold was shipped in payment.

Briefly, the striking features of the management and of the situation which have developed the property to its present enormous proportions are, on the one hand, the ownership of sources of the supplies which the company requires, such as timber, coal, and water, and the control of the railroad lines used (to avoid paying heavy freight charges), as well as the progressive policy shown in the adoption of the latest improved methods of treatment, and, on the other hand, the position of the reduction works, which are so placed relatively to the mines, although situated twenty-seven miles therefrom, as to avoid re-handling of material, coal, and ores.

THE CAUSES AND PREVENTION OF WATER FERMENTATION.

By Samuel McElroy.

RAPID progress in biological science, coming, as it does, to the aid of chemical science, and, in such cases as water analysis, furnishing what hydraulic engineers have long felt to be a needed supplement, within twenty years has changed the theories and practice of our medical authorities, and is rapidly leading, in agriculture and otherwise, to radical changes important to public welfare.

The fermentation of water is a subject which grows in importance with the rapidly-growing demand for, and distribution of, water in the various centers of population. The careful student who has collated the experience of the more populated centers on this point finds that fermentation is an active and universal law of depuration in reservoirs and other bodies of water, and demands a systematic attention which it has not, as yet, received in water-supply design.

Contamination, year after year, both in summer and winter, of the most prominent supplies has shown, at times, to any careful observer, the effects of the process by which nature depurates contaminated water. These effects have differed in period and intensity, but their occurrence has been common.

Actuated by local pride, when troubles come which should have been anticipated and prevented, city authorities have, in various times and ways, glossed over, tried to explain away, or ignored these evidences of contamination ; and quite a number of those who ought to know better—chemists, biologists, engineers, commissioners—have insisted that the trouble was only temporary, its causes more or less mysterious, its effects more or less mythical, and its sanitary effects harmless. The good name of the supply is to be guarded, and the suffering consumers are cautioned against any public clamor.

The general panacea of these wise men is flushing the mains at the street hydrants,—an operation performed at night, to save critical eyes from a shock. This shows what deposits the mains collect under their usual slow motion, and discharge under rapid currents ; and it usually aggravates the trouble, since the oxids of constant pipe-disintegration are, in themselves, valuable correctives, and, if the reservoir is contaminated by what it accumulates in its depths, the renewed supply more surely shows it, under the erroneous practice which neglects surface flow into the mains.

To the hydraulic engineer who has made this process a study, and is familiar with the theories and remedies of ancient practice, the causes and effects are plain, and the remedies equally so. Unfortunately, however, in the engineering profession struggling through a transition stage, studied experience has no adequate market value, and centers of population gain lessons by a prolonged suffering which is strangely universal.

Two great natural laws come into action here. From its abrasive weight, its absorbing power, its active solutions, and its incessant motion, water as rain, as flowing veins and currents, as expanding ice, or when distilled by evaporation, becomes rapidly contaminated in its descent through the atmosphere and its flow over, or through, the earth. It rapidly takes up, or becomes impregnated with, vegetable and animal matter, diseased or dead, and mineral salts.

Then, in the wonderful provision made for man's comfort and health, come into action the sanitary forces whose office is to depurate this organic pollution. Sunlight, as heat and otherwise, has one function; oxygen in aeration and motion has another; and the teeming sanitary police of the lower organic world, the algoid and fungoid ministry, with that of the protozoic forms, come in to fulfil their important share of the work. These forces—heat, air, and microbes—are the remedial trinity of diseased water.

The cause, then, plainly, is contamination by diseased or dead organic matter; and, since fermentation is, generally, nature's corrective remedy, the process here is putrefactive fermentation; and the odors and flavors observed are the usual evidences of this process, which must continue until depuration is accomplished. No scientific student considers heat, or oxidation, or microbes a direct cause of this phenomenon. He knows perfectly well that each is simply remedial for a distinct organic cause.

Let us now apply these premises to the supply-condition of the fourth city of the United States. Brooklyn, in 1895, is reported to have used 80,124,432 gallons of water per day, or more than 100 gallons per capita, for the twenty-five wards supplied by the city works.

The city works department, from amounts raised by tax and assessment, expended in 1895, $5,827,482, of which $761,717 was for water maintenance, including the respectable sum of $393,275 for salaries alone.

In addition, the house-holders paid $1,863,678 as water rates,—a total of $2,625,495 for the luxury of water-supply.

Brooklyn inaugurated in 1856 a supply of the highest rank in quantity, quality, and availability. The engineering theory of this plan may be thus stated:

Long Island, in the main, is composed of a porous mass of sand and gravel, sloping up from the ocean on one side and the sound on the other to a central ridge, which rises several hundred feet above tide, and contains occasional deposits of clay, bowlders, etc. The rain falling on this surface is readily absorbed, and passes down to a saturated bed, as through an enormous filter, which rises landward from tide-level, with an hydraulic frictional slope, generally of eight or ten feet per mile, except near tide. On the Hempstead plains, at a distance of 9.38 miles from tide, and a ground elevation of about 210 feet, the water stands 78 feet above,—a mean slope of 8.34 feet per mile, and a direct filtration, to reach it, of 132 feet.

Along this southern slope, easterly from New York bay, depressions occur at frequent intervals in this formation, near tide, generally as swamp beds from which powerful springs issue, forming creeks, each flowing to tide through its own valley; and there is considerable appropriation of these as mill-ponds, near tide.

Under the plan of 1856, an intercepting aqueduct was built, from the Ridgewood Pump well to Hempstead Reservoir, 12.39 miles, completely controlling a basin of 88.64 square miles. Of about eighteen creeks which it crossed, five of the more prominent were selected, their mill-ponds being formed into supply reservoirs, and a sixth was excavated on Clear stream. Abundant experience has shown their flow,—about 36,000,000 gallons per day; the rest, on a catchment of not less than 1,200,000 gallons per square mile, or 106,000,000 per day, wasting at tide unless intercepted.

In 1875, under the Kingsley *régime*, Brooklyn expended about $1,500,000 for the Hempstead storage reservoir, endorsed as capable of furnishing 100 days' summer supply of 10,000,000, in addition to the creek flow of about 8,000,000. It has a maximum capacity of 850,000,000, at a depth of 29 feet, which it has never been able to realize, and its capacity at any level suppresses the natural stream flow in proportion.

In 1892 an extension aqueduct was built, to Massapequa, a point 22 miles from the pump well, which intercepts a basin of 88.5 square miles. On this five supply reservoirs were built, credited with a gravity flow of 31,700,000, in 1895, from a total daily basin flow of about 106,000,000. The streams which feed these eleven reservoirs vary in length from 1.3 miles (Newbridge) to 4.5 (East Meadow), on the Extension, and 2.5 (Jamaica) to 3.25 (Hempstead) on the original line. They outcrop in depressed basins, in which masses of swamp growth have accumulated; various similar pond depressions occur in their descent, and the lower ponds have swamp inlets.

Jamaica valley, for a mile above the reservoir, has a broad swamp

area, about a quarter of a mile wide. In building the embankment of the South Side Railroad across it, the writer had the swamp peat excavated, in some cases to a depth of more than four feet, to get a firm slope rest.

On the extension the city acquired for aqueduct right of way and pond construction 484 acres, with 810 acres of head swamp lands, leaving about 802 similar acres on the five streams yet to be purchased; and the actual area of pond excavation, for a minimum depth of 2½ feet, appears to have been about 69 acres.

The new storage reservoir of 1875 was incomplete, when abandoned, 47 acres in the valley remaining entirely uncleared of rank vegetation. Kept, as it necessarily is, at about half-depth, rank vegetation grows at the head, to add to its supply contamination.

On the extension, then, the water, however pure when it crops out in bed-springs, is in direct steepage contact with about 1,540 acres (nearly 2½ square miles) of vegetable contamination; and on the main line no adequate effort has been made to remedy a similar exposure—for a swamp depth of 4 feet, in some cases.

In the winter, when a sleet storm comes on the frozen ground, a large surface wash into the reservoirs occurs, carrying its quota of organic matter from a highly-cultivated district and producing strong discoloration in the city mains.

As early as 1872 a supplemental supply by detached wells was commenced, below the aqueduct. This has been rapidly extended, so that, on the main line, eight stations are now in use, while, on the extension, the same method is being largely applied. Excepting two cases of "sunken wells," these are "driven tubes," using each about 100 2-inch tubes driven to great depths—45 to 90 feet or more.

Experience shows that instead of securing, as was expected, filtered water of great purity, none approaches the purity of the gravity outcrop,—about 3 grains of solid matter per gallon. The sunken well at Smith's pond, fed from it, in November, 1890, gave 3.66 grains (100,000 parts); Forest Stream, 5.84; Clear Stream, 6.04; Baiseley's, 10.28; Spring Creek, 17.96.

There are two, sometimes three, explanations. First, that, the passage along the tube downward to the suction-point being vertical, with less descent friction, and also cleared from the fine sand in interspaces, the tubes draw surface water, rather than that of the lower, horizontal beds; and this is swamp- or surface-contaminated. A property-owner and long resident on the extension says:

"I know every pump or well driven by the contractors between Freeport and Wantagh, and pumping now; nearly all of them are in swamps. . . . The pumping station at Clear Stream is shut down.

The whole pond is but little more than a morass, being overgrown with water-grass and weeds."

Of the actively-pumped and costly Spring creek well, E. H. Bartley, chemist, says in the board of health report of 1885:

"The wells (tubes) are located on low ground, near a former stream and swamp, both of which are now drained entirely dry. The distance from the Jewish cemetery is 370 yards. The land about the station is under cultivation, by frequent applications of stable manure. . . . The influence upon (neighboring) wells and subsoil water extends much farther than the distance to the cemetery. It is, in my opinion, demonstrable that the subsoil drainage from the cemetery and filthy barnyards in the neighborhood finds its way into these wells, and thence to the general water-supply of the city."

This is accompanied by an analysis, giving solid contents (100,000) of 33.4 grains and ignition loss (organic) of 12.28.

A second source of accumulated matter is found in the motionless condition of these deep beds, and their constant reception of whatever impurities reach the surface of the saturated bed, and continue to descend without being carried off. It is well known that nitrifying organisms rapidly diminish in number with increased filter-bed depth, and at these great depths they cannot act.

A third danger, and at least occasional contamination, comes from the objectionable proximity of these deep tubes to tide-line, some being not 500 feet distant, and 45 to 90 feet below tide-level. Whenever, then, the tidal pressure exceeds the landward slope pressure, in a case where these wells at work lower the saturated level 3 to 10 feet, salt water will begin to saturate the intervening bed, and, as time goes on, the supply will become more and more brackish, and must be abandoned.

To all these contingent risks and facts of contamination must be added the increase of population, agriculture, manufacture, and the like, on the feeding area of this saturated bed, and along the flowing creeks in use. Sewage, farm manure, and factory pollution must be expected, and must be provided for wisely and effectively.

The original contract and specifications for these works were drawn by the designing engineer, and the works were constructed substantially in accordance therewith. They contained three special provisions against fermentation, in a case where less than 10,000,000 per day could be used, and where the 20,000,000 provided for would not be required for fourteen years.

Under the first provision, as to the ponds below the flow lines, all vegetable and perishable matter must be cleared.

The second made the westerly supply reservoir, Jamaica, a depu-

rating reservoir for the entire supply, from which, by careful subsidence and surface-decantation, the purified flow could enter the aqueduct.

The third formed the Ridgewood distributing reservoir in three apartments, from which, by the same process of subsidence and threefold surface-decantation, through connecting wells, the purest water could enter the mains.

For the extension, then anticipated, and, in fact, provided for by the purchase of important ponds, Smith's pond was provided for a similar depurating reservoir.

In the actual construction of the original work, and on the extension, not one of these four safeguards has been properly secured;—the last three not at all. In fact, the fundamental plan of the works has been so far ignored that, when, even in 1895, the lower main aqueduct, capable of eventually carrying 100,000,000, was used for a flow of 43,800,000, the remainder was passed, at very great pumping expense, through a 48-inch main, from Millburn engine-house, though the main cost, at the outset, about $1,100,000, with a probable life of not much more than thirty years. A second more valuable 66-inch steel pipe is now under contract at nearly $1,000,000 more.

Under public clamor, and a hurried common council appropriation, steps were taken to clean out one of the ponds. As an additional safeguard a laboratory for analyses has been established at Rockville Center, to eventually determine the cause of the putrefactive fermentation.

Much credit is claimed by the department for three years' expenditure in cleaning ponds, and is due for what has been done; but there is still, on a large scale, constant exposure to local contamination, which is the source of the present trouble.

Health Commissioner Emery ascribes the bad odor and color to the "presence of living and decomposing vegetable matter in the ponds, reservoirs, and distribution system." This opinion is concurred in by Drs. Bartley, Hutchinson, and others, from personal inspection of a "large collection of decaying vegetable matter" in the ponds.

These conclusions, in the opinion of the engineer-in charge, furnish "a partial, though still imperfect, designation of the origin of the trouble, but its specific cause remains undefined." His remedy is "the continued observation, examination, and analysis of all our sources of water, so that we may become thoroughly familiar with their characteristics, and the most efficient treatment in any given case." This is further defined as, "not only chemical analysis, but color tests and biological examination, embracing that of the microscopic organisms, and that of the bacteria, as well as their complete differentiation in each case, as far as practicable; . . . .

experiments made to ascertain the mode of operation of the cause of the trouble, and corrective treatment to be applied."

The only consistent and proper remedy, then, for a dead horse on the street is a series of laboratory analyses to ascertain, as far as practicable, a suitable remedy!

The theory of the original plan was simple, effective, and economical. From a level near mean high tide, as we have seen, the vast saturated sand and gravel bed of the southern slope of the island rises towards the central ridge on an hydraulic slope of about eight and a half feet per mile. The upper roof of this slope, along the line now controlled by the Brooklyn aqueduct, daily discharges towards tide about 205,000,000 gallons of the purest filtered water, under the surface.

Could a more simple problem in hydraulic engineering be presented than the effective interception of such a flow, on such a slope, not where it crops out to be contaminated, but where it flows, clear and clean? It would make an engineer of ancient Rome turn in his grave to be told that for thirty years Brooklyn has been stumbling over this problem; that, after acquiring, at the outset, 36,000,000, with an outlay of $5,400,000, she has since expended for extensions and interest about $33,000,000, including at least $1,750,000 for wells; and that her officials have been contemplating an additional outlay of $25,000,000, to meet the demands of 1900, wandering into northern New Jersey to face a sectional State contest, when all this water, in all its purity, is running to waste, day after day, under its present aqueduct!

Nor is there much comfort promised in the eventual remedy of "sand filtration" discussed. The ancient engineers, by careful aeration and subsidence, oxidized and depurated the organic matter, and thereby, in a simple and natural way, greatly reduced the normal quantity of microbes by clarifying and removing their food-supply. But, in the expensive *single-process* sand filters of the day, so extravagantly lauded, through a bed of two and a half to four feet, all the organic matter, flood laden or otherwise, is accumulated, and with it a necessary accumulation of microbe organic slime, which pervades the entire bed, and through which every gallon the consumers drink is forced under hydraulic pressure!

For 100,000,000 per day, for Brooklyn, the estimated cost of installation plant is about $1,700,000, with uncovered beds, and $2,700,000, with covered beds; with the comfortable operating outlay of $1,200 per day, uncovered, and $1,600, covered; $438,000 per year in one case, and $584,000 in the other,—a sanitary and financial conclusion for tax-payers to study.

THE PATENT SYSTEM AS A FACTOR IN NATIONAL DEVELOPMENT.

By William C. Dodge.

THE question is sometimes asked: Is a patent system of benefit to a country? and not infrequently we find men and papers advocating the abolition of patents. Those who entertain such ideas generally belong to one of two classes,—persons who confound modern patents with the "odious monopolies" of former times, and who think that inventions would be secured just as well without patents, and those who think that labor-saving machines deprive men of employment, and are therefore injurious to the laboring classes.

This opposition has exhibited itself from the beginning down even to the present day. It is but a few years since a writer in a paper published at the capital of the United States asserted that "the invention of the steam engine and the sewing-machine were among the greatest evils that ever befell mankind"; and it is a matter of history that in the same enlightened land prayers were offered in some of the churches that the wickedness of the newly-invented sewing-machine might be made apparent, and its makers be struck with a conviction that would induce them to stop its manufacture!

More recently an organ of a labor organization insisted that the introduction of patented machinery worked injury to skilled labor, as have also the leaders of some of these organizations, and writers in periodicals, during the past year.

It is to correct these erroneous impressions that I present the following facts.

If those who confound modern patents with the "odious monopolies" granted by the monarchs would but consider for a moment, they would see how erroneous such an idea is.

Under the old system of "monopolies," rights of which the public were already in full possession were arbitrarily taken from the public and conferred upon individuals, greatly to the injury of the public. For instance, Queen Elizabeth bestowed upon her favorites the exclusive right to sell steel, salt, and other articles in the kingdom, the price of salt by the monopoly being increased from sixteen pence to fifteen shillings,—over eleven hundred per cent.!

On the contrary, a patent, instead of taking from the public anything which it already has, induces the inventor to spend his time,

labor, and money, and exercise his genius, in devising and giving to the public something new,—something which it wants, and which, but for his invention, it might never have had. True, it gives him the exclusive right to make, sell, or use the invention, but only for a brief period, and that only upon the condition that he shall so illustrate and describe it that the public can make and use it at the expiration of his limited right, and thereafter have it free forever.

The difference between a modern patent and an old-time monopoly is as clear and as distinct as the difference between day and night, and there is no excuse for their being confounded by any intelligent person. In fact, it was to abolish and prohibit the "odious monopolies" that the patent system was established.

In no part of the world have inventions been so extensively made and used as in the United States, and there can be no better way of determining whether the patent system has been beneficial, and whether or not it is for the public good to continue it, than to consider what it has done for that country.

To get an idea of what has been accomplished during the first century of American existence under the patent system, let us briefly compare the condition of the United States in 1790 with that of 1896.

Their territorial area has increased from 830,000 square miles to 3,314,220; their population from 4,000,000 to more than 70,000,000; their 75 post-offices to about 70,000; and their 1,500 miles of postal routes to nearly 500,000 miles, on which there is a travel of 409,388,425 miles,—enough to encircle the globe more than 16,000 times! In 1790 they had practically no manufactures. At the close of the revolution their manufactures amounted to only $20,000,000, the total product as late as 1830 being but $80,000,000; while in 1890 their manufactured products amount to almost $9,250,000,000—far more than those of Great Britain, and more than one-third of the total manufactured products of the world! At the same time their agricultural products have grown to the sum of $4,500,000,000 per annum.

In 1790 such things as steamboats, railroads, telegraphs, and telephones were unknown, while now the United States have 181,000 miles of railroad with a total trackage of 221,000 miles, giving employment to about 800,000 persons.

The street and suburban railways aggregate nearly 40,000 miles, of which nearly one-third are electric roads, with 30,000 motor cars.

On the 15,000 miles of western navigable rivers, and 95,000 square miles of lake surface, there are 2,705 steamers, with a tonnage of 806,584 tons, while the craft on these inland waters number 10,237 with a tonnage of 4,319,734 tons. The traffic on the great

lakes alone amounts to nearly 40,000,000 tons. During the eight months of navigation 60,000 vessels pass through the Detroit river, with a tonnage of over 36,000,000 tons. The tonnage of entrance and clearance of the two ports of Chicago and Buffalo exceeds that of any city in the world, except London, and very nearly equals that (London, 20,962,534; Chicago, 10,288,868; Buffalo, 9,560,590). From the single port of Escanaba, on Lake Michigan,—a place so young as to be unknown abroad, and known to but few at home,—there were shipped in 1892 nearly 4,000,000 tons of iron ore, and 120,000,000 feet of lumber,—her tonnage being more than half of that of Liverpool, which is excelled only by that of London.

The United States produce now more iron ore, and manufacture more iron and steel, than Great Britain, which heretofore has led the world in that line. They have 839,905 miles of telegraph wires, with 25,000 stations, independent of ocean cables, and 440,750 miles of telephone wires, with more than 500,000 instruments in use.

But, wonderful as these statistics show the growth of the country to have been, they do not tell the whole story; for it must be borne in mind that in 1790 the four millions of people were scattered mostly along the Atlantic seaboard in sparse settlements. Moreover, it must be remembered that this small number of settlers had the whole continent to subdue,—forests to clear, farms to open, houses, roads, bridges, schools, and churches to build, in fact, everything to create, with the savages to contest every foot of advance,—and that the western continent had neither the accumulated wealth or the surplus labor of the old world with which to accomplish this gigantic task. But even that is not all, for, in order to get a clear idea of the conditions under which the United States began existence as a nation, one must consider also the restrictions placed upon the colonists by the mother country.

The policy of the mother country from the very first was one of suppression of all manufacturing industries. As early as 1621 an order of the king and council prohibited the shipment of tobacco or any other production of the colonies to any foreign port, except to be first landed in England, and a duty paid on it there.

This policy was continued even after American independence, and various acts, from 1781 to 1796, were passed, prohibiting under heavy penalties the shipment from Great Britain of "any machine, tool, engine, press, paper, utensil, or any part thereof, or any model or plan thereof, which was, or thereafter might be, used in the manufacture of woolen, cotton, linen, or silk manufactures," and also prohibiting the shipment or enticing away of any artificer or workman in these several branches; and in 1795 this act was made perpetual.

It was not until 1825 that the restriction upon workmen leaving the country was repealed, and that upon machinery not until 1845.

The object of all this, as stated in the preamble to the act of 1763, was "the keeping of his majesty's subjects in the colonies in a firmer dependence," "the increase of English shipping," and "the vent of English manufactures." The idea and purpose of the British government in reference to the colonies was succinctly stated by Sir Robert Peel, when he said: "It is the destiny of the United States to feed Great Britain, and the destiny of Great Britain to clothe the United States."

Of course, under such control by the mother country, the colonists could engage in nothing but farming and the production of raw material, to be shipped to England for the use of her manufacturers.

During the revolution, manufactures were established to partly supply home needs, but with the close of the war a reaction set in that soon destroyed most of them. Under the confederation of the colonies, which was solely for common defence, the general government had no power to grant patents, or to regulate commerce, or to impose duties on foreign goods, those rights being exercised by each colony or State as it saw fit. Massachusetts, New York, and those most interested in commerce, imposed no duties, and the result was that, in a year or two after the close of the revolution, the country was so flooded with the cheap products of England and other countries as to break down all the manufactures that had been established during the revolution and bankrupt the merchants. So terrible was the condition of affairs that petitions were sent to congress asking it to issue "fiat" paper money, and loan it to the people. In Pennsylvania the State government actually did this.

It was this condition of affairs which finally resulted in the constitutional convention in 1787, which conferred on congress the powers under which the country has since grown to its present estate. Among the powers conferred on congress by the constitution, two of the most important, so far as national prosperity and growth are concerned, are the power to regulate commerce and impose duties on imports, and the power to provide for the grant of patents. These may well be termed the right and left arms of American growth and prosperity, and it is a question which, after all, is the right arm, and which the left. Under the exercise of those two powers, for the first century of existence, the United States have so grown and prospered that they now do one-third of the world's manufacturing, one-third of its mining, and one-fifth of its farming, and possess one-fifth of its wealth. And, best of all, this is the result of peace, and the intelligent application of the arts.

Now, what has caused this marvellous growth? Doubtless there are several causes. The cheapness of a virgin soil and free institutions inducing immigration from abroad were two of the causes; but those alone do not account for it.

By some it is contended that the tariff has been the prime cause of American prosperity. Without desiring to discuss that or any political question, and admitting that a tariff is necessary for national revenue, and that it has been, and is, of importance to the manufacturing interests of the country, I assert, without fear of successful contradiction, that the patent system of the United States has been, and is now more than ever, one of the prime causes of national growth and prosperity.

As stated by Commissioner Leggett in his report for 1878, from three fourths to nine-tenths of all American manufacturing is based, directly or indirectly, on patents; that is to say, the people are engaged in manufacturing patented articles, or are using patented machines and processes to manufacture articles not patented.

One need but step into any shop where articles are being produced—from the saw mill in the woods that now cuts its 300,000 feet per day, to the little shop in the attic where toys are produced, or the great factories turning out their millions' worth of articles of every variety—to prove the truth of this statement. In fact, you cannot touch a thing anywhere, in the shop, on the farm, in the household, or the office, that does not bear the impress of patented inventions.

But to show that this is not merely an individual opinion, let me quote what an intelligent Englishman says on the subject. Harris Gastrell, secretary of the British Legation, in a detailed report a few years since to his government upon the industries of the United States, says:

> I cannot close this report without recording the fact that, in every important branch of industry referred to in the course of the previous pages, the American manufacturers seemed to be ever gaining on their competitors of the old world *by availing themselves to the utmost of every advantage of improved process or labor-saving machinery* which American or other inventors may offer.
>
> There can be little doubt but *the celerity with which all such advantages are thought out and then introduced into general use* is owing to the constant pressure of high rates of wages, and *the comparative certain protection of capital invested in inventions.*
>
> Neither can I close without observing how favorably the great industries of the United States would probably compare with the best organized of the competing industries of Europe. The past history and present development of the textile (and metal) industries is an earnest of a prolific future. Whether or not a reduced cost of living shall ever be attained, I cannot doubt that, under sound conditions of production, American industry will *not only supply its own market, but will also become a formidable competitor in foreign markets* in many articles.
>
> How soon that competition abroad may take place in this or that industry is not

for me to conjecture. But I think that the data in this report are sufficiently full and correct to enable others to predict that time in respect to the cotton and woolen industries.

At a meeting of the British Association, after his return from the Philadelphia Centennial Fair, Sir William Thompson said:

I was much struck with the prevalence of patented inventions at the exhibition; it seemed to me that every good thing deserving a patent was patented. I asked one inventor of a very good invention: "Why don't you patent it in England?" He answered: "The conditions are too onerous." We are certainly far behind America's wisdom in this respect. If Europe does not amend its patent laws, America will speedily become the nursery of inventions for the world.

Mr. Hulse, the English judge of textiles, in his report to parliament, said:

The extraordinary extent of ingenuity and invention existing in the United States and manifested throughout the Exposition I attribute to the natural aptitude of the people, *fostered and stimulated by an admirable patent law system.*

So, too, the Swiss commission were so impressed by what they saw at Philadelphia that they published an address to their manufacturers, in which they told them that their only hope was in the adoption of a patent system; and the result was that Switzerland in 1888 adopted a patent law.

The United States consuls, in their reports to the State department on the effect in Europe of the Centennial Exhibition in 1876, show how American implements and products were being preferred in Europe, especially agricultural machines and tools; and Consul Winser gives long extracts from a book published by Dr. Herman Grothe, a prominent German political economist, who visited the fair for the sole purpose of "studying the principles which had operated so powerfully in bringing about this rapid and high development of American industries," and who lays great stress on "the *stimulating effect of the patent laws.*"

Dr. Grothe further says:

Moreover, owing to the use of labor-saving machinery and finer and better-adapted tools, the cost of manufacture, in spite of higher wages in the United States, is lessened to the point where competition with other nations in supplying foreign markets may fairly be tried; and there can be no doubt that a great many lines of American wares will eventually find ready sale in the German market, in some cases to the exclusion of the same classes of goods of English, French, and even home manufacture. All this is granted.

In the reports of the British commissioners to parliament it was stated that, "as regards extent of invention and ingenuity, the United States was far ahead of other nations"; that "a great part of the marked advance in the improvement of workmen's tools which has been made during recent years is justly due to the inventive genius of American citizens"; that "one cannot fail to notice the great

fertility of invention displayed in America"; that "there is great inventive power, and a ready and fearless adaptation of the means to the end sought"; that "no one could fail to be struck with the great and successful application of science to useful purposes in America"; and that, "judged by its results in benefiting the public, both by stimulating inventors and by giving a perseveringly practical turn to their labors, the American patent law must be admitted to be the most successful, and the beneficence of its working was very amply illustrated throughout the American region of the Exhibition."

Edward Bally, one of the Swiss commissioners, said:

> I am satisfied from my knowledge that no people have made, in so short a time, so many useful inventions as the Americans; and, if to-day machinery apparently does all the work, it nevertheless by no means reduces the workman to a machine. He uses a machine, it is true, but he is always thinking about some improvement to introduce into it, and often his thoughts lead to fine inventions or useful improvements.

As a result of these obvious facts, a committee of the British parliament some years ago, after two years of investigation, recommended the adoption of the American patent system, and again in 1894 the subject was agitated. Norway and Sweden in 1885, Canada in 1886, and Germany in 1888 adopted a similar system of preliminary examination, and now they grant patents only for what is new and original. Thus the foremost manufacturing nations of Europe recognize the superiority of the American patent system, and make acknowledgment of its beneficial results.

Now, when the United States manufacture more than they consume and seek other markets for a surplus of both manufactured and agricultural products, the patent system more than ever becomes important; for, with higher-priced labor and raw material, how are goods to be made there, and sold in Central and South America, in open competition with the cheaper labor and cheaper raw material of England, France, Belgium, and Germany? If the cost of both labor and material could be reduced to a European basis, then, of course, America could compete; but that cannot be done, for the price of labor cannot be fixed by law, nor would the United States want to reduce it, if it could. That was tried in England and also in New England, and abandoned centuries ago.

The main hope is in inventions, and the skill and energy of the American people. If inventors can furnish manufacturers with improved machines and processes, which will reduce the cost of production from fifteen to twenty per cent., then the new world can compete with the old world; otherwise not. Already that point is rapidly approaching, as the following facts show:

In 1830 the manufactured products of the United States amounted to but					$80,848,210
By the census of	1850	they had grown to			1,019,109,616
"	"	1860	"	"	1,885,861,676
"	"	1870	"	"	3,385,860,354
"	"	1880	"	"	5,369,579,191
"	"	1890	"	"	9,224,541,094

or, according to Mulhall, more than one-third of the total manufactured products of the world!

This remarkable increase has been largely, if not mainly, due to inventions, stimulated and fostered by the patent system. As proof of this I cite the fact that the amount per hand employed has constantly increased. For instance, as shown by the census reports, in 1850 the product per hand, yearly, was $1,564, while in 1890 it had grown to $2,250,—an increase of nearly 44 per cent. in forty years. During that time the hours of labor have been reduced at least 20 per cent., and yet the product per hand has increased, as above shown. Nor is this all, for, while the hours have been decreased, and the product increased, the wages paid those hands have increased in even greater ratio, or from an average of $247 per year in 1850 to $450 in 1890, an increase which is even further augmented if measured by the purchasing power of a dollar then and now.

Now, how is it, and what is it, that enables an operative to-day to produce so much more, in a less number of hours, than he could thirty or forty years ago? It is simply *invention*, as embodied in the improved machines, tools, processes, and appliances that American inventors are constantly furnishing to American manufacturers.

Near Baltimore there was recently erected one of the largest plants for the manufacture of Bessemer steel in all its forms in the world; and, as recently stated by its superintendent, by means of the inventions and improved appliances they have adopted they are enabled to produce a ton of steel with but one-third of the manual labor required at their other establishment, built twenty or twenty-five years before.

In 1866 steel rails cost $165 per ton. In 1884 they had dropped to $34, in 1893 they were $21 to $24 per ton, and in 1897, even less. See how that has expedited the building of railroads, which now cover the country like a net-work, and without which modern existence could not be carried on. And the same is true of steel in all its forms, so that to-day we build steel bridges, steel vessels, steel cannon, steel frames for our buildings, and for farm implements, and use steel nails.

Inventions and improvements have so reduced the cost of steel rails that already, during the year 1897, the United States have sold 100,000 tons to Europe. They sold 100,000 tons of pig iron from

the southern states in 1896, and this year it is estimated that it will be 250,000 tons, where before the war none was produced. In 1896 the American export of iron and steel, manufactured and unmanufactured, amounted to over $41,000,000.

As an illustration of the benefits of invention, take the common nail. In 1818, when they began to be made by a machine operated by hand in Pennsylvania, they cost from 18 to 37½ cents per pound, according to size. Now they are sold at 1 to 1½ cents per pound,—so cheaply indeed, that a carpenter, working for 30 cents per hour, had better let a nail go than to spend ten seconds to pick it up, for ten seconds of his time is worth more than the nail!

In a report made by the United States consul at Birmingham, he cites a paper prepared by an English expert, who forcibly describes the danger from American competition to the British manufacturer of steel.

That is the result of invention. And the same is true of nearly all branches of manufactures. Says the *Iron Industry Gazette*:

"Disparagement of patents is common and easy, but it should not be forgotten by those who sneer at inventors that, out of a total of over $8,000,000,000 of capital invested in manufacturing in the United States, patents form the basis for the investment of about $6,000,000,000. Evidently, the United States system of encouraging invention that has resulted in the patenting of over 500,000 inventions is a system that is exceedingly wise and valuable. *The one thing that has enabled manufacturers to make so wonderful a progress in the United States is its patent system.*"

THE ARCHITECTURAL RELATIONS OF THE STEEL-SKELETON BUILDING.

By F. H. Kimball.

THE layout or arrangement of a large modern office-building, or of any building exceeding, say, eight or ten stories in height, is influenced to a great extent by the methods to be employed for upholding the structure. As the height or the number of stories is increased, walls of masonry alone soon become structurally impracticable by reason of the great thickness sure to be developed in the lower stories and the consequent loss of rentable area. The architect must therefore study, and in his design be influenced by, the best means in vogue for carrying the floors, together with the loads likely to be imposed thereon, as well as all the walls, both interior and exterior.

Our building laws, before the high-building period set in, were such as possibly to develop walls of three or four feet in thickness in the first story; but, whatever reduction of rentable space resulted, clients were apparently satisfied. In fact, they had no choice, as there was no appeal from the law in this respect. This state of things does not prevail in every city. In some of the large cities compilers of the building laws seem to have more faith in the adhesive and sustaining qualities of brick and stone masonry, but in New York city they are more conservative. It is a matter of conjecture whether the controlling motive was lack of confidence in the fidelity of our builders to use the best of everything, or a desire to emulate the example of those in olden time who "builded better than they knew,"—whose works were imperishable, standing to-day as monuments to the honesty and ability of those commissioned to build them. It is fair, however, to take a charitable view, and believe that our building laws are more perfect than those of other cities.

It is not to be regretted that the master minds which gave us all we have to-day, architecturally speaking, knew nothing of modern expedients in construction. It is scarcely possible to conceive what they would have done with a sixteen- or twenty-story building, while preserving the breadth and repose of the examples handed down to us. We do not know what exterior effect they would have produced where the walls were hung on a steel cage, with all the accompanying restrictions as to weight and thickness; how they would have preserved an apparent stability of pier and wall space, and secured at the same time well-lighted rooms for any kind of business; nor with what suc-

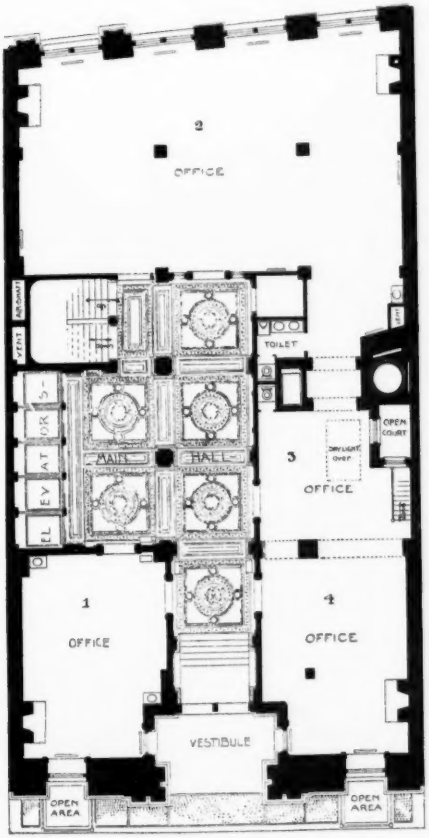
cess they would have met the many bugbears in the form of girders for the support of walls, and columns to carry them by which modern architects are oppressed. It is natural to suppose that the genius which created and developed architectural styles would no doubt have solved such problems with greater skill than that shown by the architects of to-day. Whether they would have clothed their tall buildings with masonry, or, recognizing the lightness and pliability of metal as an external skin, would have devised some preservative treatment whereby the life of the metal might be so prolonged as to make it commercially valuable, it is impossible to conjecture. When we study the great examples of masonry construction, one of the greatest and the first being the Duomo at Florence, followed by St. Peter's at Rome, it seems fair to presume that something would have been worked out with great boldness of design and construction.

Would they have considered the subject from the engineer's standpoint? That is, given a rigid steel frame composed of columns and girders supporting floors of steel beams filled in with masonry, braced to withstand any degree of wind-pressure without the need of other reinforcement than of metal, would they not have devised and attempted to preserve the same degree of lightness throughout by conceiving some covering of a similar nature to encase this frame? Or would they have used materials which have no affinity for metal, forming a covering of great weight, perishable, difficult to replace when injured or destroyed by fire or the elements, and, after all, suggestive of something which does not exist, for there is no evidence of the substance back of the covering? Not that we should make evident the structural supports in the design, but it is a common custom to "thin down" the piers and wall surfaces of a building, for the purpose of amply securing well-lighted rooms, at the expense of correct architectural composition.

While the beauty of stone and brick in color and texture is not to be questioned, conditions may arise which demand a radical departure from the traditions that dictate their use. In place of stone or brick, why not use iron or steel plates, or a composite plate, bolted or riveted to the steel frame? This could not be considered a return to the cast-iron imitation of stone masonry which prevailed twenty years ago. A more rational and natural use of metal might be devised which would not have the elements of a cast-iron front. Possibly the treatment of its exterior surface by a preservative coating would give it the desired color effect, and at the same time save frequent painting. At any rate, there may be a thought in this which some architects will eventually attempt to work out, and the effort may lead the way to something better.

THE MANHATTAN LIFE BUILDING, NEW YORK.

THE BOWLING GREEN BUILDING, NEW YORK.
By the courtesy of W. & G. Audsley, Architects.



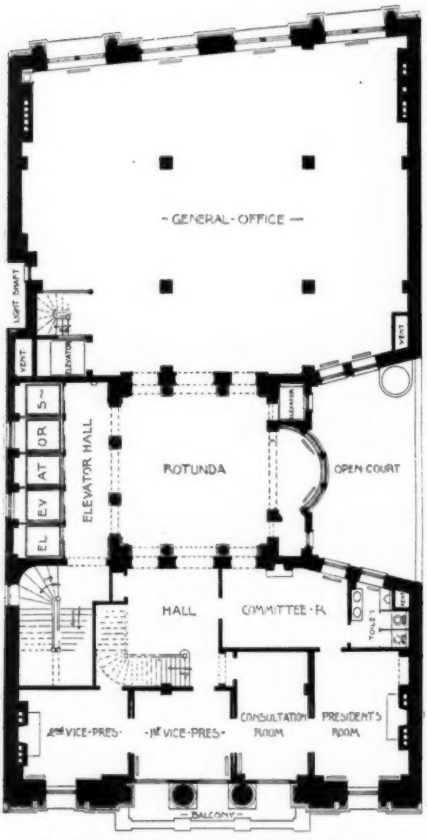
MANHATTAN LIFE BUILDING, NEW YORK.
FIRST-FLOOR PLAN.

In the designing and laying out of a building in which the use of a steel frame is contemplated, the architect of to day has far more to think about and provide for than he had under the older systems of construction. The external design and interior arrangement, to a certain degree, must be worked up together. It is essential, however, that the arrangement shall conform to surrounding conditions, principally as to the available source of light, whether that source be the street, or courts, or both. Then must be considered the placing of the entrance to the building,—whether at one side, or directly in the center of the architectural composition,—and its relation to the elevators, which must be conveniently placed where they will best serve the interests of the tenants and public for quick access and at the same time occupy space of least value for rental purposes. These two features are most important in the design of a building. The elevators must also be considered in connection with the plan of the upper stories.

In determining the constructive features it is necessary to consider the location of the structural supports. A cut-and-dried spacing of the supports—that is, columns regularly arranged, just so many in the depth at an even number of feet and inches apart, and just so

THE COMMERCIAL CABLE BUILDING, NEW YORK.
By the courtesy of Harding & Gooch, Architects.

NATIONAL BANK OF COMMERCE BUILDING, NEW YORK.
By the courtesy of James B. Baker, Architect.



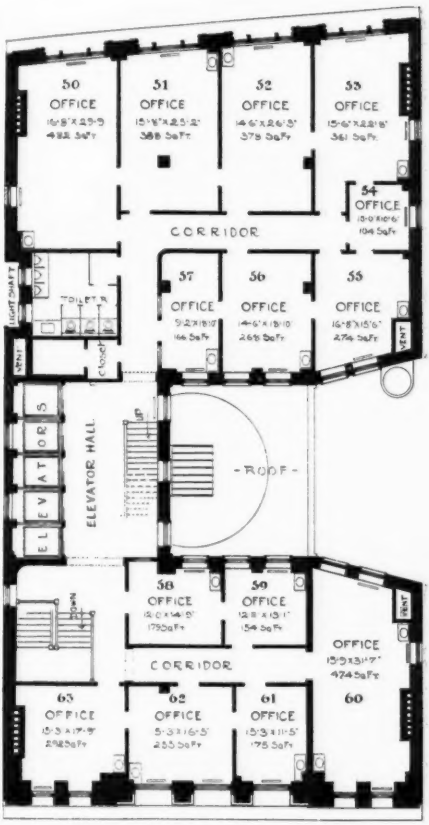
MANHATTAN LIFE BUILDING, NEW YORK.
SIXTH-FLOOR PLAN.

many at equi-distant spacing in the width—is in many instances impossible. It simplifies the engineering problem, but is sometimes incompatible with results which an architect strives to obtain in the treatment of halls or specially large rooms, such as corporations require. Again, a line of columns may come so near a division wall or partition as to make it desirable to put them out of sight; or there may be stories of a special character (similar to the sixth and seventh stories of the Manhattan Life Building, with which the writer is identified), where it is desirable to bury the columns, or, failing that, to dispose of them with some regularity and method of arrangement.

This means that an architect must consider, so far as the interior columns are concerned, each and every story through which they pass, before he can definitely fix their location. Economy should also be considered in spacing the columns within certain limits, for the reason that, where they are placed far apart, increased weight of metal is requisite in both the supporting girders and the columns, and heavier floor beams are needed, and the greater concentrated loads at the base of columns involve a more extensive foundation.

To be taken into serious consideration also are the location and probable depth of girders supporting the floor beams. As a rule, the

depth of such girders is greater than the floor beams which they carry. They may drop a foot, and sometimes much more, below the general ceiling level. It is advisable by some means to bring this impediment into some logical and harmonious relation to the architectural and decorative treatment, whatever it is, or to find some treatment naturally growing out therefrom. But, where a story is cut up into many rooms to suit the notions and desires of tenants as to floor-space, regulated to a large degree by the depth of their pocket-books, no attention is paid to this subject.



MANHATTAN LIFE BUILDING, NEW YORK.
A TYPICAL FLOOR PLAN.

Next in order is the position of outer wall columns, which must be covered up in the piers or come in the wall spaces—anywhere except in a window. They are regulated, as a rule, by the design of the exterior, though sometimes they regulate the design. Some columns carry the ends of floor girders, and are, in a measure, fixed. Sometimes it is possible to line up all exterior wall columns with those of the interior, simplifying both manufacture and erection. But the rule as to short spans for purposes of economy, and rigidity as well, applies here too. As the walls must be supported on girders, it is vital that the spans should not be excessive, especially in cases where girders support three stories of wall.

The system and character of bracing and tying together the ex-

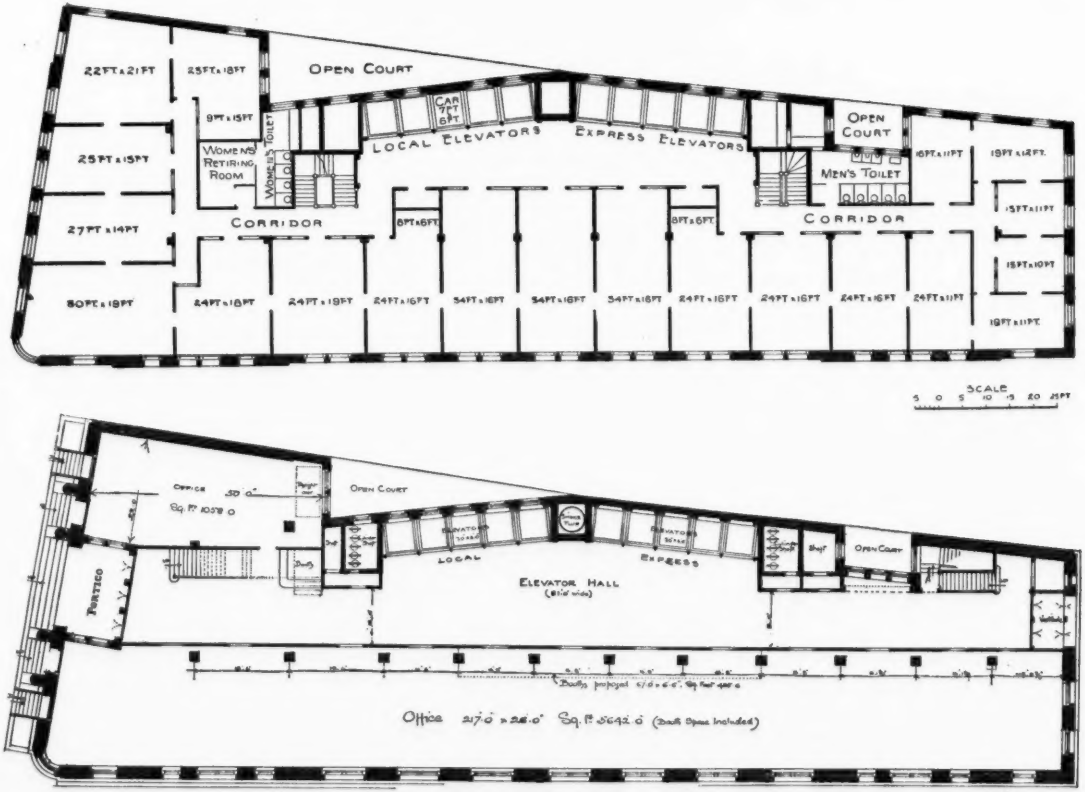
THE CORN EXCHANGE BANK.

THE GILLENDER BUILDING.

THE ST. PAUL BUILDING.

Copyright, 1897, by Geo. B. Hall & Son.

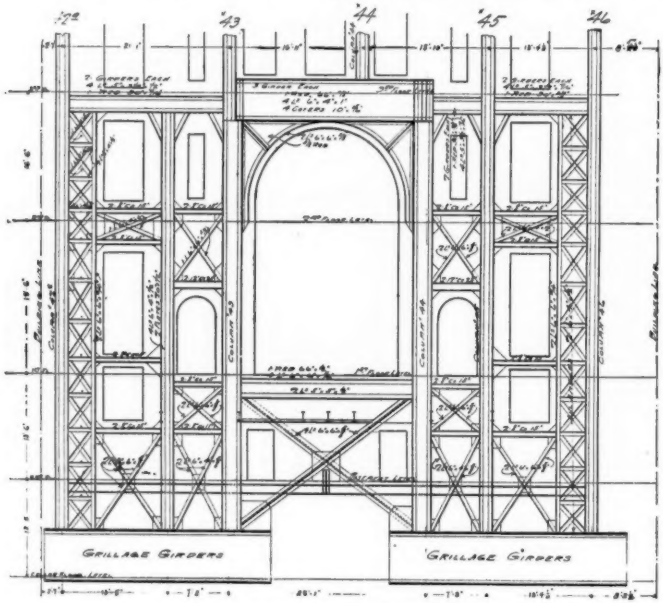
SOME RECENTLY ERECTED TALL BUILDINGS IN NEW YORK.



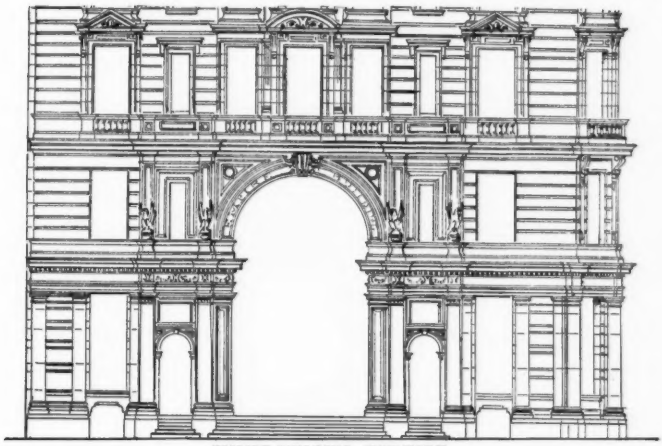
EMPIRE BUILDING, NEW YORK. FIRST-FLOOR PLAN, AND TYPICAL FLOOR PLAN, DIVIDED.

terior wall columns and girders to resist wind-pressure can, to a great extent, conform to the wall-spaces placed at the disposal of the engineer by the architect in his design, but sometimes, as in the case of a narrow frontage with long side exposure, the height of a building demands special bracing, to accommodate which there must be an adjustment of the architectural composition. The accompanying illustration of the first two stories of the Broadway front of the Empire Building, Rector street and Broadway, is an example. Notwithstanding the greatest care on the part of the architect and his assistants, it is difficult to guard against every contingency and keep the structural frame amply covered and protected.

In the placing of outside wall-supporting girders in the case of a stone front it is desirable to locate them where cornices or band courses occur, so that the heavy stone forming these features may run through the wall and be borne on the girders, thus acting as corbels on which the walls above may be carried, up to the next horizontal line of girders. This system permits the erection of any part of a front independently of the other parts, if deemed advisable. It is



EMPIRE BUILDING, NEW YORK.
Elevation of the lower part of the skeleton frame, Broadway front.



EMPIRE BUILDING, NEW YORK.
Elevation of lower part of Broadway front, as it will appear when completed.

well to say that it is not popular in this city to skip about in this manner in building an outside wall; when a start is made, whether at the first or second story, it is safer to continue to the top uninterruptedly, course by course. There is a possibility, however, that, in case of defacement or serious damage by fire, such portions may be removed and restored with greater facility than in former days.

The protection of the structural frame imbedded in the outside walls has been the cause of much discussion and variety of practice. Some architects advocate placing the column supports entirely within the wall. This involves heavy bracketing out from the columns to support the girders carrying the walls, as well as a loss of floor-space, besides eccentrically loading the columns. The method most employed is to so place the column that it shall have the protection of from eight to twelve inches of masonry between it and the outer air, and treat the metal with a moisture-resisting paint or composition. Much depends on the design of the column. It will be conceded by those familiar with the subject that the best form of column is one so designed as to offer a minimum exposure in the direction from which moisture is likely to penetrate the walls. Therefore an open column, through which masonry may be built entirely surrounding the metal, the webs being placed at right angles to the walls, should secure the best and most lasting results in freedom from injury by moisture or by heat from external fires. This rule applies to girders generally, although there are conditions prohibitive of forms other than those with webs of rolled plates.

The protection by fire-proofing of all skeleton frame work, columns, girders, and beams in the interior of a building, demands nearly as much study as that spent upon their location. This is particularly true in the case of columns. An adequate water-protection must be capable of resisting the pressure of a stream from the most powerful engine. To secure such resistance, and to properly protect a column against injury by fire surrounding it, the column should be enclosed in a burned-clay blocking of at least four inches in thickness, laid in the very strongest cement and carefully bonded together at the angles. This, however, means an enlargement to eight inches more than the neat size of the metal, so that a column which, in the first story, measures twenty inches across, will increase to a measure of twenty-eight inches. This forms an obstruction difficult to dispose of in a manner eminently satisfactory to client and tenant, as the increased sectional area absorbs floor-space. Sometimes this is further augmented by the pipe lines of various sorts being carried up on the columns. It is aggravating enough to make such display of features which it is most desirable to conceal; but, when these pipe lines must be carried up on one side of a column on which a girder centers, then the architect's cup of misery is full to the brim. Very possibly he has designed and worked out an elaborate decorative treatment in the earlier stages of his work, and, just when ready to take the matter up and put it into the hands of the builders, he is compelled to begin all over again, and do something else much less satisfactory.

He finally overcomes the difficulty, and, when this is done skilfully, it is noticeable how sadly out of proportion the appreciation of his efforts is to the amount of hard thinking he has given the subject.

The tying up and effacement of all the odds and ends of protruding constructive detail, especially without incurring extra charges on the part of the contractor, requires considerable thought. It sometimes leads to irritation on the part of the client that provision for such detail was not incorporated in the original specification. But it can hardly be otherwise, for it is scarcely practicable to provide for every contingency of this nature, even where ample time is allowed, and quite impossible in the short time usually granted the architect to prepare full plans and detail drawings.

The final effort of an architect, after he has plans, design, and construction well thought out, is to devise a suitable foundation to sustain his creation. He began at the bottom and worked up to the roof to perfect the arrangement of floor-space, and then began at the roof and worked down to the cellar to perfect his construction and find out what it all weighed in tons and pounds. Now it is to be determined what the sub-structure must be. Will the nature of the

THE EMPIRE BUILDING, NOW BEING ERECTED IN NEW YORK.

ground admit of a grillage foundation, composed simply of girders and beams resting on a bed of concrete, or are the accumulative loads so great that nothing short of bed-rock will suffice to safely carry the structure? The point must be determined beyond doubt or question, and the building secured against any settlement other than the natural adjustment of the various conflicting parts. The problem has been much simplified since the introduction of the caisson found-

ations, the first of the kind being used for the foundation of the Manhattan Life Building, 66 Broadway, New York city. When the proper foundation system has been decided upon, designing of the shoes and metal base to receive and support the carrying columns must be considered with reference to bulk as well as sustaining qualities.

The installation of the generating machinery requisite to operate the several systems requiring power, such as are needed in every modern building, for heating, lighting, elevator, plumbing, and ventilation, demands provision for more than one boiler, and sometimes half a dozen. These various mechanical systems must be so disposed throughout the cellar as to work advantageously one with the other. A bulky mass of grillage, with its fire-proof enclosure, would, in many cases, seriously upset any practical arrangement of machinery, if not altogether prevent its use.

It, therefore, becomes incumbent on the part of the engineer to so distribute his loads by means of girders or cantilevers as to offer the least obstruction in the floor-space ; at the same time he must keep in mind the fact that all of these different systems require piping which must be run above and across the grillage in all directions, and that no grillage must be of such height as to encroach upon the free and uninterrupted right of way for this purpose. This may compel him to bury one or more layers of grillage under the the surface of the cellar floors, but, when this means under water, he must seriously consider the natural life of metal exposed to continual moisture, the necessity of proper protection, and the nature of the protection which will be surely efficacious in repelling moisture for a long period.

It will be apparent to the reader that an architect has much to do to design and carry to a successful issue the many problems continually arising in the erection of a large building. Only the constructive elements have been herein referred to. A thorough inspection of one of the large modern buildings from cellar to roof would best serve to show the visitor the manner in which every part has been thought out, and could not fail to impress him favorably towards the architect and those who have faithfully carried out his views.

The rapid development in electrical science, steel-construction, sanitary appliances, heating and ventilation, elevator service, in fact all that goes to make up a modern building, compels an architect to keep himself well-informed in these subjects so that he may intelligently direct the experts he may call upon to assist him in perfecting the details of their special professions. The better grasp the architect has of these subjects, the more likely he is to achieve satisfactory results.

THE DEVELOPMENT OF THE STEEL RAIL IN THE UNITED STATES.

By H. G. Prout.

A BAR of steel thirty feet long, of simple and uniform cross-section, may appear a little thing. In its effect on human happiness, however, it is a very important thing, and, as an engineering construction, it has puzzled many able minds. A past president of the American Society of Civil Engineers, who is not lacking in the sense of humor, said: "Looking at the rail on end, it is a very small affair, six or eight square inches in area, but, when looked at in longitude, we find that it is over 600,000 miles long, and every inch contains a blunder." It is my purpose to try to give, briefly, some notion of the importance of the steel rail to mankind, of the variables that have perplexed designers, of the blunders that they have made, and of the success that they have had.

A few years ago a distinguished company of foreign iron and steel workers was gathered in Chickering Hall, New York. They were delegates from the British Iron and Steel Institute and from the Verein Deutscher Eisenhüttenleute. They were visiting the United States to see some of the work done there in the noblest of the metals. The great incident of the day of which I speak was the presentation of the Bessemer gold medal to an eminent American, Mr. Abram S. Hewitt. In his address Mr. Hewitt said that "the invention of printing, the discovery of the magnetic compass, the discovery of America, and the introduction of the steam engine were the only capital events of modern times which belong in the same category as the Bessemer process." He said further that "Sir Henry Bessemer has contributed more than any other living man to that condition of industry which compels all who are engaged in its conduct to combine on a scale unknown before his time in the work of economic production and equitable distribution. A serious, if not fatal, blow at the domination of what may be termed the privileged classes of Great Britain was struck, unintentionally doubtless, by the invention of Bessemer. It is apparent that the structure of the British government will necessarily undergo very serious changes, and Sir Henry Bessemer has been the great apostle of democracy."

Mr. Hewitt meant that Bessemer had brought about one of those epoch-making changes in economical conditions that are working steadily through the generations and through the centuries to make life easier and broader for the great mass of mankind,—those changes

through which the poor and the lowly rise in knowledge, and wealth and power and the classes disappear. And this effect of Bessemer's work comes chiefly in reducing the cost of transportation.

The introduction of railroads made an industrial revolution, and nothing less; but the progress of that revolution seemed to have about reached its limit in the decade between 1860 and 1870. The further progress in economy and efficiency in the great machine of transportation called for increased weights on all wheels, and especially on driving-wheels, and the advance in public service called for greater speeds. But the iron rail went to pieces under the weights imposed upon it and under the shocks of the blows of heavy machinery at high speed. Early in the sixties it had begun to be obvious that rolled iron rails would not permit much further progress in weight and speeds. The limit of development was apparently to be found in the cost of maintenance of track, and, notwithstanding the increasing volume of production, the price of iron rails was rising. For seventeen years they had sold in the United States at an average of $57 a ton; in 1862 they were below $42, and in 1864 they jumped to $126. The price was trebled in two years. This was the result partly of the civil war, and partly of conditions affecting rails especially. The average price of gold in 1862 was 116¼; in 1864 it was 204½. A proportionate rise in rails would have carried them up to $74 a ton; but they rose to $126, and we must conclude that a very large part of this rise was from the effect of the demand for them for new work and for repairs. Train weights could go no further, and rates charged for service could be reduced no lower without ruin to the railroads. It seemed in 1864 as if the limit of endurance of railroad track had been reached, and as if progress stood confronted by one of those physical facts which sometimes stop the way for centuries.

The maximum price of iron rails was reached in 1864; but steel as a possible relief had already begun to be talked of. Ten years before, in 1854, Bessemer began the series of experiments which led to the discovery of the pneumatic process. In trying to get a good gun-iron, he perceived that cast iron might be rendered malleable by blowing air through the fluid metal. In 1855 and 1856 he took out his first patents for the pneumatic process, and in 1858 actually converted cast iron into cast steel.

But in 1857 Mushet got hold of some metal that had been de-siliconized and de-carbonized by the Bessemer process, remelted it in a crucible, added spiegeleisen, and made a steel rail, which was actually laid in the tracks of the Midland Railway, remained there for five years, and carried a million and a quarter trains. This was, so far as I can learn, the first Bessemer steel rail ever rolled.

But it took a good while to get to rolling steel rails commercially, and in 1867, ten years after the first steel rail was put into service, they still sold in the United States for $166 a ton. The American production in that year was 2,550 net tons; but from that time on the price fell fast. In 1877 it was $45.50; in 1887 it was $37; and now it is about $20. The production rose from 2,550 tons in 1867 to 432,160 tons in 1877 and to 2,354,132 tons in 1887. This was the banner year in the United States,—the year in which about 13,000 miles of new track were built. Since then the new mileage of railroads has never approached that length, and the output of steel rails in America has never been so great. In 1896 the United States built about 1,700 miles of railroad, and rolled 1,100,000 tons of steel rails.

But the steel rail came, and once more the way was clear for the progress of the industrial revolution. The first steel plant on a commercial scale built in the United States was established in Troy, and made its first blow February 15, 1865. This was established by Messrs. Winslow, Griswold & Holly, Holly being, of course, the engineer, and the man who furnished the greatest part of the science, enthusiasm, and imagination. In June, 1867, the Pennsylvania Steel Company made its first blow at Steelton, near Harrisburg, this plant also having been designed and built by Holly. From this time steel mills followed fast. The first steel rails rolled in the United States were a lot of six, rolled by the North Chicago Rolling Mill Company in May, 1865,—eight years after Mushet rolled his experimental rail in Wales. These were rolled from ingots made at an experimental plant at Wyandotte, Mich., and they were doing service in track ten years later. The first commercial rolling was at the Johnstown works of the Cambria Iron Company in August, 1867. These rails were rolled for the Pennsylvania Railroad Company from ingots made by the Pennsylvania Steel Company works at Steelton.

I have tried to give a notion of the timeliness of the introduction of the steel rail. I wish that I could stop to say something of the men who started that vast business in the United States. There are few stories so stirring in the industrial annals of the world. Reputations and great sums of money were risked on what was still an experiment. The men who invested their reputations and their money stood to make a colossal success or a colossal failure. These early steel-makers were men of ability, enthusiasm, and prodigious courage. Some of them are still alive and active, for this industry began in the United States only thirty-four years ago. I can mention, however, only three or four of them; first among them, and far above all the rest, stood Holly, the man of genius. He had the soul of the poet, the energy of the soldier, the intellectual grasp of the

philosopher. I have said that he was a genius; and his life illustrates the saying that genius is the capacity to toil terribly. He burned himself out and died at fifty, having accomplished great things, and loved by his comrades as few men are ever loved. I have often been touched by some words of his which show the vein of tender sentiment that ran through his bright and manly nature, and the apt felicity with which he could express himself. In 1879 a group of friends united to give Holly a piece of silver plate. The presentation occurred at a little party arranged for the occasion, and it was a surprise to Holly. In receiving the gift, he made a short speech, closing with these words: "Among us all who are working here in our noble profession and are keeping the fires of metallurgy aglow, such occasions as this should also kindle a flame of good fellowship and affection which will burn to the end. Burn to the end; perhaps some of us should think of that, who are burning the candle at both ends. Ah, well, may it so happen to us that, when at last this vital spark is oxidized; when this combustible has put on incombustion; when this life-fire flickers thin and pale at the lips,—some kindly hand may turn us down—not underblown; by all means not overblown—some loving hand may turn us down, that we may perhaps be cast in a better mould." Many admired his brilliant intellectual gifts; and a choice group of the best men admired him and loved him because he was not only greatly endowed, but generous, frank, modest, and devoted to duty. And perhaps of all his shining qualities this last—his devotion to duty—was the noblest.

Probably after Holly the first rank should be given to the two Fritzes, George and John, plain, uneducated men, but men of talent and character. They built up the great works at Johnstown and at Bethlehem, invented many appliances, and did much to create the Bessemer art. Captain Jones, long engineer and superintendent of the Edgar Thomson Works, was another man much like the Fritzes, a characteristic American, preëminently a self-made man, clear-headed, rugged, and resolute. He died as he had lived, at his post of duty, in a blast-furnace accident at the Edgar Thomson Works.

Robert Forsyth, another of the leaders, lately chief engineer and vice-president of the Illinois Steel Company, was sent to Chicago by Holly to superintend the erection of the original North Chicago Bessemer Works, of which he afterwards had charge. He designed the converting department for the South Chicago Works, and later rebuilt the Union Works at Chicago, and finally came to be the technical chief of the consolidated mills.

Robert W. Hunt, whom I shall have occasion to mention again, has been identified with the steel industry for thirty-seven years. He

has been an acute and enterprising student and executive man, and is to-day one of the highest authorities on steel rails. He was a lifelong friend of Holly, as well as of the Fritzes and Forsyth.

FIG. 1. IRON, 84 LBS. 1857.

We will now trace briefly the development of the cross-section of the steel rail, and will then return and analyze the sections somewhat carefully. In the diagrams the figures in vertical column on the right give the proportion of the metal found in each of the principal members. Thus in Holly's section (Fig. 2) the head contains 37 per cent. of the total, the web 29 per cent., and the flange 34 per cent.

It was natural that the earliest steel rails should have followed the iron rails closely. The prevailing shape of the flat-footed iron rail at this period was the pear head (Fig. 1), which had been adopted to prevent the sides of the head from breaking down; so long as one had to deal with a weak metal, it was a good section. But Holly had already grasped the idea that a rail should be designed to give better service as a beam, and he concluded that, if it was made of the best re-heated soft iron, with a thin and elastic head, and deep, as a girder, it would not only wear well, but carry well. As early as 1856 he designed a section to embody these ideas (Fig. 2). But this form, I think, was never rolled. The English mills controlled, and stuck to the pear-head for flat-footed rails rolled for export.

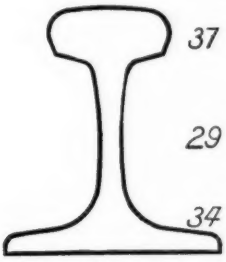


FIG. 2. HOLLY, 58 LBS., 1858.

In the United States, however, better practice began even before the era of steel. In 1864 Mr. Ashbel Welch designed a section for a 62-pound iron rail, 4½ inches high, with a four-inch base, and such an angle under the head that a fish-plate could be applied. This was very similar to his later steel section (Fig. 3). Many thousand tons of rails of this pattern were rolled, and they did good service. The half-inch stem never gave out, nor did the head or base crack off at the sharp re-entering angle, as many engineers anticipated.

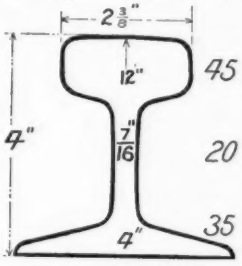


FIG. 3. WELCH, 53 LBS.

In passing, I may say that Mr. Welch

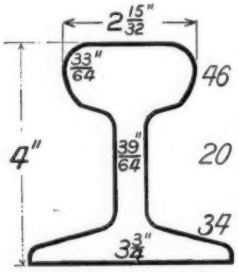


FIG. 4. MANY ROADS, 60 LBS., 1870.

was a remarkable figure in the engineering profession, and became president of the American Society of Civil Engineers. He was a man of gentle manners, but clear, analytical mind and resolute character, and was one of the longest-headed men of his generation. It often surprises me to see how, in various branches of the art of railroading, he anticipated, twenty or thirty years ago, the best American practice of to-day.

As I have said, the earliest type of steel rail was the pear head. In 1866 Mr. Welch designed a section for a steel rail (Fig. 3) embodying the ideas which he had put into the iron rail. He found it difficult to get this rolled. The great steel makers of Sheffield, John Brown & Company, tried to persuade him of the folly of it, but it was finally rolled without much difficulty, stood a remarkably good drop test, and was laid in the spring of 1867 at points where the iron rails were giving out most rapidly. These rails performed so well that they were quickly followed by others of the same pattern, and, after carrying ten million tons of freight, there was not a broken rail among them, although heavier steel rails of the older type frequently broke.

Naturally, the Welch section soon spread, and for a while it determined the type in America; but in 1874 Mr. Octave Chanute, then chief engineer of the Erie railroad, brought out a section (Fig. 7) which was the progenitor of what has been the standard type in the United States until very lately, although it was modified until in 1880 the rail mills were carrying rolls for perhaps three hundred sections, all closely resembling this type, but so far departing from it that, as Capt. Jones said, a rail mill had to have a ten-acre lot to hold its rolls. This section is generally known as the Chanute section, but the Bethlehem Iron Works rolled something very much like it for the Lehigh Valley Railroad, after the designs of Mr. Sayre, two or three years earlier. Probably, however, Mr. Sayre and Mr. Chanute designed their sections independently of each other. The essential departure from the Welch section is in the greater amount of metal in the head, the straight and somewhat flaring sides, and the thin web and flange.

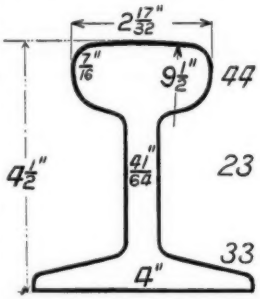


FIG. 5. P. R. R., 67 LBS., 1870.

With the Chanute-Sayre type as a basis,

engineers went on to develop rails with deeper and bigger heads, especially in the vertical dimension, with straight and sloping sides, and robbing the web and the flange for the sake of getting metal in the head of the rail, where the wear came. But presently a new school of design sprang up; people began to discover that the steel rails with big heads actually did not wear as well as the light John Brown rails and other rails of English and American make rolled to the Welch section; and it began to be suspected that the fault was in the design of rail rather than in the chemistry of the metal or the mill processes. In 1883 Mr. P. H. Dudley designed for the New York Central & Hudson River Railroad an 80-pound rail (Fig. 11) which was an important departure from the common practice. He made this rail five inches high, and gave it a broad and shallow head. This design marked an epoch in rail sections, and, while it is difficult to ascribe exactly the credit due to each man in the change which gradually followed, it is certain that Mr. Dudley has had great influence in bringing about the present section. It must be kept carefully in mind that I speak now of Mr. P. H. Dudley, of dynagraph fame. Mr. Hawks, chief engineer of the Michigan Central Railroad, came out in 1889, with a rail (Fig. 12) similar in design to Dudley's. In both of these rails the characteristic departures from previous design are found in the head, relatively broad and thin, and with such a distribution of the metal as makes what has come to be called a balanced rail; that is, the percentages of metal in head and flange are approximately the same. In 1889 also Capt. R. W. Hunt brought out designs for a series of rails, weighing 60, 65, 70, 75, 80, 85, and 90 pounds, with the general characteristics shown in the sections devised by Mr. Dudley and Mr. Hawks.

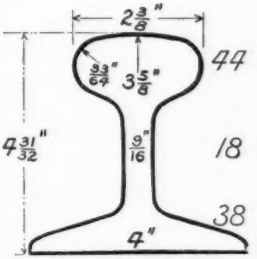


FIG. 6. D. L. & W., 61 LBS., 1874.

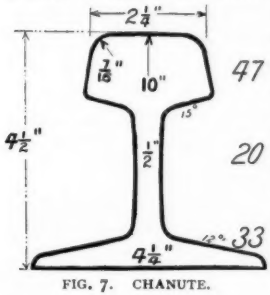


FIG. 7. CHANUTE.

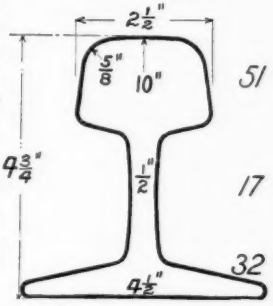


FIG. 8. P. R. R., 75 LBS., 1885.

In the period between 1883 and 1889

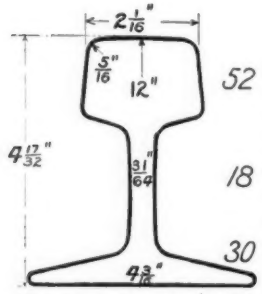


FIG. 9. C. C. C. & I., 65 LBS., 1885.

there had been a good deal of discussion of the proper section of rail (Dudley, Hunt, Hawks, and a few others taking the burden of the argument), which resulted in the appointment in 1890 of a committee of the American Society of Civil Engineers, instructed to present to the society designs for what might be adopted as a series of standard sections. This committee, after long consideration, presented in 1893 a series ranging from 40 up to 100 pounds at 5-pound intervals, and this series is nearly identical with the designs of Hunt and Hawks (see Figs. 14 and 15). Mr. Dudley, however, who was not a member of this committee, brought out in 1890 a complete series (see Figs. 16 and 17 for types) embodying his ideas, which differ slightly from those of the committee of the Society, although designed on the same general principles.

We will now again run over the record of rail sections, and analyze the types, one after another, with a view to getting at the logic of them, and determining in our own minds who, of the various designers, has come nearest to the absolute truth.

Mr. Welch's section (Fig. 3), the first serious departure from the pear-head type of rail, was designed with a view to a rational use of the superior material. The pear-head form had been used to prevent an inferior rail from going to pieces, and it was an excellent form in which to roll slag and cinder, and the baser metalloids. Mr. Welch conceived that, with steel, it would be possible to adopt proportions in which the metal should be disposed to give the greatest endurance against abrasion. Thus a thin stem and base would give sufficient strength, while the mass of the metal could be put in the head. This shape also gave surfaces to which the fish-plate joint could be applied under the head, doing away with the necessity for laying the end of the rail in a rigid cast-iron chair resting on a tie,—a method which subjected the rail to a blow between a heavy hammer above and an anvil below. He designed, therefore, a rail 4 inches broad at the base and 4 inches high, with a head 2⅜ inches wide and 1¼ inches deep,

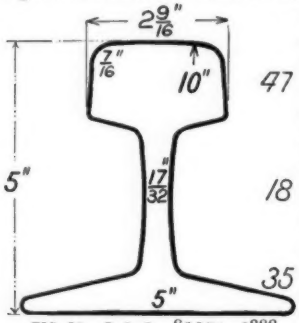


FIG. 10. P. R. R., 85 LBS., 1888.

giving the top a curve of 12 inches. The stem was only $\frac{7}{16}$ of an inch thick, and the fishing surfaces under the head and on the top of the flange were inclined at an angle of 14 degrees with the horizontal. I do not discover that Mr. Welch went much further than this in elaborating the theory on which his rail was designed, but it is singular that in so many particulars he came, in this very early type, close to the form which now prevails in the standard recommended by the committee of the American Society of Civil Engineers, and which embodies the fundamentals of the Dudley-Hawks-Hunt sections. In the distribution of metal he got more in the head and less in the flange than the Civil Engineers' standard series,—that is, 45 per cent. in the head as against 42, and 35 in the flange as against 37. The radius of the crown is exactly that adopted in the latest standards,—namely, 12 inches. The width of the head between the origins of the corner curves is but $\frac{1}{8}$ of an inch less than in the Civil Engineers' 70-pound rail, and is $\frac{1}{8}$ of an inch more than in their 55-pound rail. The Hawks 80-pound rail has almost precisely the proportions of the Civil Engineers' section, and, so far as the distribution of metal goes, is very close to Mr. Welch's section of 1867. Mr. Welch does not seem to have gone into the chemistry of the rail, or to have considered very much the effects of his proportions upon the physical quality of the metal after it passed through the rolls; this was natural, for the whole science and art of steel-rail making was developed after his section was designed. Considering that he worked in the very dawn of that science and art, before a single principle had been established, it is wonderful that he should have come so near to what seems now the best American practice. And this is another instance of the singular clear-headedness and far-sightedness he so often displayed.

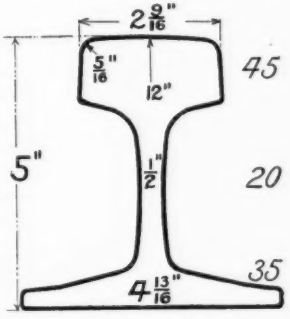


FIG. 11. DUDLEY, 80 LBS., 1883.

The Welch section had a great influence on the early steel rails, and soon determined their proportions, so far as American practice went. The three early designs (Figs. 4, 5, and 6) are

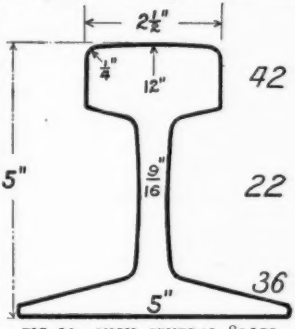


FIG. 12. MICH. CENTRAL, 80 LBS., 1889

interesting departures from the Welch section. The 60-pound section of 1870 was very popular. The effort to get a fishing angle under the head is observable, and it will be seen that the weight of metal in the head has been increased very slightly beyond Mr. Welch's design. The Pennsylvania Railroad 67-pound rail of 1870 is essentially the Welch section. The Delaware, Lackawanna & Western 61-pound rail of 1874 is chiefly remarkable for the very short crown radius,—namely, 3⅝ inches, which, I suspect, is a mistake of some draughtsman or printer. The very unfavorable fishing angle is also noticeable.

Then came the Chanute-Sayre school, about seven or eight years later. Mr. Chanute (Fig. 7) reasoned that the place to put precious and costly steel (rails in that year being worth $68.75 a ton in the United States) was where the wheel-wear came,—that is, on the top of the head. Therefore, he piled up a deeper head than had prevailed in the progeny of the Welch section. The percentage of metal rose from 45 to 47 in the head, and fell from 35 to 33 in the flange, the web remaining the same. The width of the top of the head diminished slightly, the crown radius was shortened 2 inches, and the sides of the head were bounded by straight lines and were flared. The prevailing idea was to put the metal on the top of the rail, where the wheel wear came. Precisely why the crown radius was reduced to ten inches I do not remember; perhaps Mr. Chanute did not explain. Presumably, however, it was partly because that radius lent itself to a higher head, and partly because he discovered that the rails in service tended to wear to this radius. The flaring of the sides was to give a greater fishing surface under the head. Singularly enough, he adopted two different angles,—15 degrees under the head, and 12 degrees on the top of the flange. This doubtless was for some sufficient theoretical reason, which it would now be a waste of time to inquire into. Observe, too, that Mr. Chanute makes the upper corner radius of the head $\frac{7}{16}$ of a inch. These points of the $\frac{7}{16}$-inch radius and of the flaring sides should be kept in mind, because we shall have something more to say about them presently. The Chanute-Sayre section fast prevailed as against the Welch section, and became the typical section, although engineers departed from it in large and small particulars, each man designing his own section. In 1880 Holly estimated that there were about three hundred sections more or less in use in the United

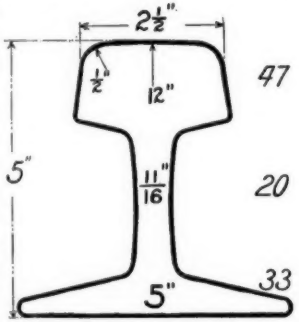


FIG. 13. P. & R., 90 LBS., 1888.

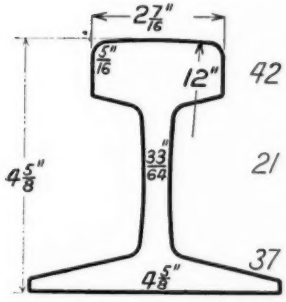


FIG. 14. AM. SOC. C.E., 70 LBS.

States. About 1890 I tried to form an idea of the variety of sections. I found that in four of the large mills rolls were carried for twenty-four different sections of 60-pound rails alone, and that there were twenty-nine different weights between 56 and 85 pounds. There were rails weighing 58 pounds, 58¼ pounds, and 58½ pounds per yard; again, 66, 66½, 67, 68½, and 69 pounds. As nearly as I could get at it, these four mills must have carried rolls for more than one hundred and eight different sections, for rails upward of 56 pounds per yard and in current use, besides still other rolls for sections that were then obsolescent. It is astonishing, in looking over the section-books of the rail mills, to see the trivialities in which the engineers departed from other men's designs, in order to put their names on their own sections. Thus we find the widths of flange measuring $4\frac{5}{64}$ inches, $4\frac{1}{32}$, and $3\frac{5}{16}$; one man, who preferred the decimal notation, actually carried his flange width out to five places of decimals. Of course there could be no possible engineering reason for such refinements, even if rails could have been rolled with such nicety. They make one think of John Phœnix's celebrated case, in which the engineer paced the diameter of the circle and then multiplied it by π carried out to 14 places of decimals. Holly's explanation of this rage for thirty-seconds and sixty-fourths was that it was largely a matter of human vanity; that it was very gratifying to Stiggins to have the rail mills and the chief engineers of various railroads study the drawings of Stiggins's section. But, whatever the reasons, the result was waste of human energy, one of the greatest of modern crimes. Every time a rail mill got a new order, it had to change its rolls. There was no possibility of rolling standard sizes of rails and stocking them, and thus equalizing the output, which is obviously one source of economy. And the misery of the situation was that no earthly good was served by this variety. Fortunately, owing largely to the

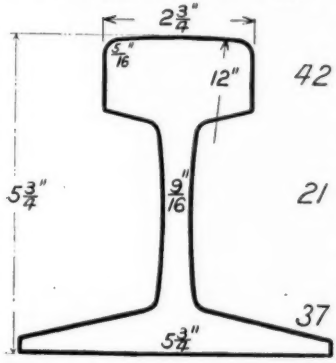


FIG. 15. AM. SOC. C. E., 100 LBS.

labors of Dudley, Hawks, and Hunt, of the committee of the American Society of Civil Engineers, aided somewhat, I trust, by one or two editors, the tendency is now towards simplicity and uniformity.

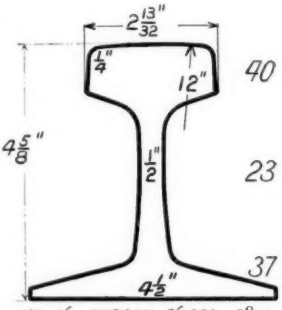


FIG. 16. DUDLEY, 56 LBS., 1890.

But let us return to the Chanute section. It was brought out in 1875. It quickly became, with slight modifications, the standard of the Erie. By 1885 it had taken such forms as that of the Pennsylvania Railroad (Fig. 8). This is a 75-pound section, larger in all dimensions than Mr. Chanute's 62½-pound section. The piling up of metal in the head has gone on, until the Pennsylvania rail has 52 per cent. of its total weight in the head. The crown radius remains 10 inches; the width from out to out is 2½ inches; between the origins of the corner curves it is less than 2¼ inches. The corner curve has a radius of ⅝ of an inch, thus making the top even more convex than in the Chanute pattern. In 1888 the Pennsylvania people brought out an 85-pound rail (Fig. 11), in which, for some reason or other, they returned to what, in the light of the present day, seems to be rather better proportions, but not much better. The metal in the head is still 47 per cent. of all, and the crown radius is 10 inches, but relatively the head is a little broader, and not quite so deep. A glaring case of the bad influence of the Chanute-Sayre theory is shown in the 65-pound rail of 1885 of the C. C. C. & I. (Fig. 9). Here the metal in the head is 52 per cent. of all, and the top between the points of origin of the upper corner curves is only 2 1/16 inches wide. Fortunately, the designer reduced the upper corner radius to 5/16 of an inch, and increased the crown radius to 12 inches, thus getting a fairly good crown. If he had not done so, the narrow head which he designed would have been much worse than it was.

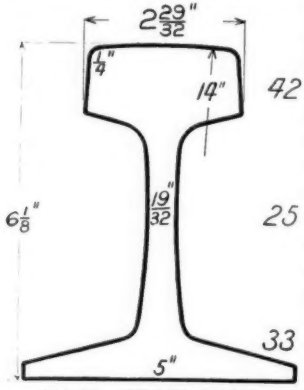


FIG. 17. DUDLEY, 100 LBS.

This short review of the history of the steel rail has brought us up to the epoch-making change which may be said to have had its beginning about ten years ago. Another article will treat more specifically of the reasons for that change, and of its results.

ELECTRICITY IN THE MODERN MACHINE SHOP.

By Louis Bell.

II.—COST-REDUCTION AND LABOR-SAVING BY ELECTRIC APPLICATIONS.

IN all American machine-shop practice, labor is the item of expense which must be most carefully watched. Hence labor-saving machinery of every kind is employed to keep down the wages-cost of manufacture. The use of electric motive power has proved exceedingly important in this work of economy, and, as its applications are made the subject of more careful study, it will effect greater and greater saving. At present its use is growing rapidly, but it is generally directed toward only the more obvious tasks.

It is interesting to recall that the first electric motor ever put into commercial use was for the specific purpose of saving manual labor. This was at a beet-sugar works at Sermaize, near Paris, and it is recorded that during the winter of 1878, while it was in use working a small hoist for unloading beets at the river-front, it saved no less than forty per cent. of the previous cost of unloading, and handled four thousand tons of beets. The saving must have given a pretty good return on the investment.

Hoisting is obviously a work to which mechanical power can be applied with great advantage, and, from the ease with which electric power can be transmitted to moving motors, it has come into very extensive use for this purpose. For most such work it has great advantages over other methods of applying power, although for certain purposes the smooth celerity of the pneumatic lift knows no equal. Large numbers of electric hoists, derricks, and travelling-cranes are now in use in all sorts of manufacturing establishments, and the time and labor saved by them reach a prodigious aggregate. One gets a vivid idea of it in watching an electric travelling-crane, worked by a skilful operator, pick up a five-ton casting and shoot with it to the diagonally-opposite corner of a big shop, working all three motors at once, and finally land it precisely where it is wanted, without a perceptible jar.

Similar in function are the electric tramways, which have now become common in extensive works, shifting material from shop to shop, and taking machines on their way to completion through the course of travel that modern methods of subdividing labor (sometimes carried too far) seem to necessitate.

These applications of electric power are of the cruder sort, dealing with familiar problems in a somewhat commonplace fashion, but they

FIG. 1. MAGNETIC-MOUNTED ELECTRIC DRILL.
The Portable Electric Drill Co.

are tremendously effective in saving expense. Much more interesting, although used at present on a far smaller scale, are some of the devices used to facilitate particular mechanical operations.

One of the neatest applications of this sort is the employment of portable electrically-driven drills. Holes have to be drilled in masses of metal of all sorts of odd and inconvenient shapes and at all sorts of angles. In many cases the common drill press cannot be used at all, and then it becomes necessary to rig clamps to hold the drilling machine to its work, after which the drill is laboriously worked by hand. If many holes have to be drilled, this work is very slow and costly; so it occurred to some one to drive the drill by a portable electric motor, and so do the actual boring as rapidly as if the work could be mounted on a drill press.

An apparatus of this kind was introduced a few years ago in the Brooklyn navy yard, where several of the new cruisers were being built. It consisted of a portable motor, neatly boxed in and connected to the drilling machine by a long flexible shaft. The drill was clamped into place, and the work then proceeded very rapidly. Several of these machines were at work on the frames of the cruisers, drilling rivet-holes. Another was successfully used in enlarging the port-holes in the turrets of the monitor Miantonomah. Steel armor plate a foot thick or so is not the easiest thing in the world to cut, and, when the port holes had to be increased some inches in diameter to accommodate the new 10-inch rifles, by boring out an elliptical ring of armor, the task was most forbidding. But one of the electric drills was set in place, and it kept boring away until the port was completed.

A more recent type of drill for ship work is that shown in Fig. 1. In this case a still further simplification is accomplished by giving the motor and its worm-driven drill a universal mounting upon four adjustable magnetic feet. When placed fairly upon a ship's plates, these have an adhesive force of nearly half a ton each. The drill can then be adjusted and clamped, and will then bore holes up to an inch in diameter as fast as it can be safely worked. The whole affair weighs

only about 220 pounds. Portable drills of similar character are considerably used abroad.

These portable drills, particularly when the clamping is magnetic, save an immense amount of time, and could be very profitably used in many metal-working establishments. A small size, such as could easily be moved about a single man, would be invaluable in general machine-shop practice and in modern building work. The main requirements are portability and a quickly-adjustable magnetic clamping system. A portable metal saw built on similar lines should occasionally prove useful.

Before drifting too far from the subject of cranes, I should note a very clever contrivance in use in the South Chicago works of the Illinois Steel Company. In the rolling of boiler plates, the resulting sheets—say, three feet wide and twenty or more feet long, weighing from a quarter to half a ton—are very inconvenient to handle, and, when they must be moved, are very inconvenient to sling. The electrician of the works, who has distinguished himself by various neat applications of electric motive power, promptly came to the rescue, and fitted the mechanical travelling-crane in the plate room with a magnetic grip. A pair of powerful electromagnets are dropped down upon one of the long plates, which, thus held at two convenient points, is sent flying down the room and dropped into place, saving a deal of labor. In any case where many iron masses of moderate weight have to be carried on travellers this magnetic grip saves much trouble; it takes hold hard and instantly, and lets go when desired, without the bother of unhitching.

A more directly mechanical labor saving application of electric power may be found in the electric working of various automatic machine tools. Large saving is effected by the use of tools so arranged as to require little attention while running, and these machines have come into extensive employment. A case in point, where electric power has been very judiciously employed, is the cutting-off lathe shown in Fig. 2. It is driven by the small motor mounted directly upon it, whose speed is automatically varied as the feed progresses. As the tool works in toward the center of the bar, the motor speed rises, so as to preserve a constant cutting-speed of about thirty feet per minute. This device minimizes the time necessary for a cut, and the machine requires little labor of attendance. Some experiments with heavy lathes show that a direct motor drive enables more power to be concentrated in the machine than can be conveniently applied to the same size of lathe by the ordinary method of belting, so that heavy cuts can be taken more expeditiously,—in fact, up to the limiting speed which the tool will stand.

As an obviously useful addition to the automatic class of machines, magnetic clutches and cut-offs can often be advantageously used to cut off the power and put the machine out of service when its work is, for the time, done, or reverse it when necessary. In fact the electro-magnet may be, and often is, used in automatic machines to simplify what might otherwise be a very complicated mechanical motion. Nevertheless experience has shown that such devices must be used with great caution, for, while thoroughly reliable under good conditions, contacts will wear out and get rough, so that the ceaseless repetition of a single small motion had generally better be effected mechanically, if possible.

It should be noted that ease of application to automatic adjustment is sometimes a good reason for using directly-driven electric tools, even when no particular saving in power can be made.

In another class of cases it is desirable to have delicate control of the speed, and this is obtained more easily and conveniently by changing the speed of the motor than by any arrangment of cone pulleys or variable gears. An ordinary shunt-wound motor with a capacious rheostat in the field circuit gives very perfect speed-control over a

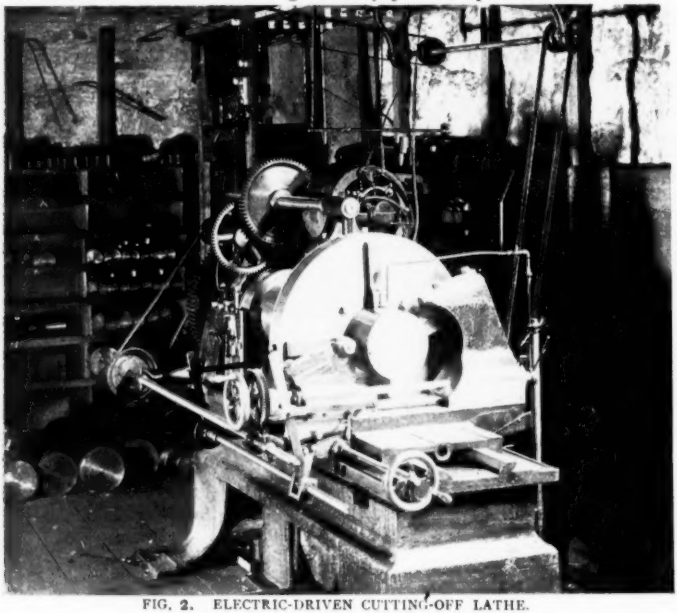


FIG. 2. ELECTRIC-DRIVEN CUTTING-OFF LATHE.
General Electric special shunt-wound motor.

moderate range, and, assisted by cone pulleys giving, say, three speeds, enables very delicate adjustment of the speed to be made over the entire working range. Special shunt-wound motors give this control over a considerable variation, unaided by any change in the pulleys, and in extreme cases the assignment of a small special generator to feed the motor at any required voltage gives a very perfect control of the speed over almost any required range. Fig. 2 shows an instance of this method of regulation.

FIG. 3. ELECTRIC SOLDER-IRON. Ward-Leonard Co.

Another and most interesting labor-saving application of electricity may be found in the department of electric heating. It now and then happens in mechanical work that a constant and very portable source of heat is necessary. It goes without saying that, in mere cost of heat, cheaper sources can be found than electric current. But, when, for instance, a very large amount of soldering has to be done, much time is lost in changing irons, and in working with irons not just at the proper temperature. Under such circumstances an electrically-heated soldering iron facilitates operations immensely. It is always hot, and always just hot enough. Consequently these tools have proved useful. The first application of them ever seen by the writer was in soldering the caps on full cans of kerosene for export, in which case the irons had to be heated in another room until electricity came to the rescue. Fig. 3 shows a modern iron for general shop-work. In other shops an electrically-heated solder pot and ladle shown in Fig. 4 has proved useful in extensive soldering, relining bearings with Babbit, and the like, keeping the metal always at the best working temperature. The extreme ease with which electrically-generated heat can be regulated is not infrequently a great economizer of time and trouble—which means money. A capital example of such use is found in the electric vulcanizer for bicycle-repair shops, which keeps the tires just hot enough for the purpose without special attention. Every bit of human care that can be avoided means wages saved, and, while these heating devices may

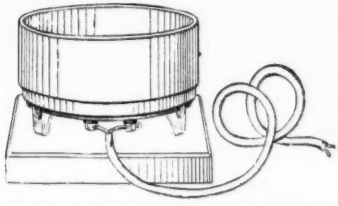


FIG. 4. ELECTRIC-HEATED SOLDER-POT. American Electric Heating Corporation.

FIG. 5. ELECTRIC HEATED GLUE-POT.

at first sight seem almost trivial, they do save the time of the workmen. These are typical of not a few other applications of electric heating, all tending to minimize attention to things outside of the mechanical process in hand. I note that they do not save anything in cost of heat, and are to be regarded as purely labor-saving contrivances,

In general, it is very often suggested that the use of electric power, with its great convenience of application, steadily tends to get more and better work out of the workmen. In a measure this may be true, and yet in many cases electric driving is really no more convenient than ordinary belt-driving. It is quite as easy to move a belt-shifter as to start a motor; in fact, the latter process requires rather more attention than the former, and it is doubtful whether the moral effect, so to speak, of electric driving produces any permanent effect on the efficiency of the men.

The greatest single source of saving in labor among all the applications of electricity in shops is really electric lighting. Good, clear, steady illumination is of itself valuable, and the ease with which incandescent lamps can be adjusted to throw a steady and brilliant light upon the work in the evening or during the twilight hours of a winter's day is a very important advantage. Men will do more and better work with electric light than with any other, for their attention can be concentrated on the mechanical process without the distraction of straining the eyes in an indifferent light.

For machine-shop lighting the ordinary arc light is a nuisance from the intensity of the shadows thrown by it, and the consequent sudden contrasts between brilliant, glaring illumination and intense obscurity. If the work requires very complete lighting, inverted arcs with large reflectors give the nearest approach to daylight that can be obtained by any artificial means. As the luminous crater of the arc is directed upwards, the real source of light is a dead white reflector, three or four feet in diameter, suppressing all glare, but illuminating most thoroughly.

In default of this, or to supplement it in extreme cases, excellent work can be done by incandescents supplied with reflectors and suspended over the machines on universal brackets. The ordinary flexible cord is not enough, except in cases where the work is always the same for a given machine; for, if the light is wanted in a special position, a quickly-adjustable support is necessary.

The uses of electrical appliances directly for saving labor without material change in methods of work are thus not as general as one at first thought would suppose. Aside from saving in cost of power, the greatest gains are shown in cases where labor is saved by a new process, rather than by the adaptation of electricity to an old one. The most striking exception to this rule is in the line of tramways, hoists, and cranes, already discussed. In any machine-shop work where much material has to be moved, or heavy objects have frequently to be handled, the economist should at once turn, in most cases, to electric power. In large works it is sometimes startling to note the distances that have to be travelled by a machine and its component parts from the time the raw material enters the gates until the finished product leaves the shipping-room. All this travel is wasted work, which has to be paid for, and rather dearly if only manual labor is applied to it. It is one of the disadvantages of the extreme subdivision of labor that can be obviated only by cheapening the process of carriage. As a rule, the installation of electric apparatus for doing all this work will pay well.

Aside, then, from the savings to be effected by lessening the power-cost of production, discussed in a previous paper, we may set down electric portative devices as the most direct method of lessening the labor-cost—a method which may advantageously be coupled with general motor service, even if no further special applications are contemplated. In investigating a concrete case with reference to the adoption of electric power, this is one of the first points to be considered. If the shop examined is one where artificial light has to be used to any extent, there is a strong added reason for using electricity, unless a lighting circuit has already been installed.

The next step is to examine into the matter of special machines. The merits of the case depend largely on the class of work being done, and the extent to which the machine tools are systematically used. If a given machine, when in use, is turning out a routine product at a uniform speed, electric driving from the labor standpoint has no particular reason for being. If, on the other hand, it is being used for a large variety of purposes and at all sorts of speeds, it may well happen that merely the matter of speed regulation, enabling the tool to be worked at its most advantageous rate of cutting all the time, will show good reason for electric driving. Again, in cases where a single man tends several semi-automatic machines engaged even on uniform work, the use of electricity may render it possible by automatically changing the feed or speed, or even by automatic stopping on the completion of certain work, to lessen the attention required, and so give a single man command of more machines, or at least quicken the work of those

already in use. This line of improvement has not been followed far in general machine practice, and deserves much more attention than it has received. We have plenty of automatic machines for special purposes, but comparatively few that can be turned to a variety of purposes.

Again, the question of portable tools has a very various degree of importance in different shops. In most shops doing heavy work it has great weight, while in those turning out a light and uniform product it can hardly be considered of much importance. The electric drill has already been discussed, and, while even now considerably used, would really fill a very useful place in most large machine shops. In some cases portable metal saws and milling tools, emery wheels, and buffers, would prove exceedingly convenient, and would save a great deal of work now done with cold chisel, scraper, and file. To all such devices electric power lends itself with extraordinary facility, and there are few shops were portable tools of such a kind would not prove highly economical of labor. It is a field that can profitably be explored by the inventor as well as the engineer.

Finally, we come to a class of electrical applications which have to do not so much with an improved application of existing tools as with the convenience of the skilled workman, whose time is far too valuable to waste. Such are in themselves often apparently trivial, like the electrically-heated soldering iron, or even a magnetized screw-driver to facilitate certain assembling work, but they do save time, and time is money, if anywhere, in manufacturing-processes requiring much manual labor.

And, aside from all this, there is a further field for applied electricity, greater and more interesting than any of these—the changing, not of motive power or implements, but of methods. The mechanical arts have already been enriched in this wise by the labor of many investigators, and as yet we have seen but the beginning. Of this beginning and its lessons I will speak briefly in the next paper.

BOILER-SETTING AND FURNACE-CONSTRUCTION.

By Edgar Kidwell.

IN engineering, as in art, perfection of the whole implies perfection of all the details. In a steam plant every component part, from the coal-pile to the engine fly-wheel, has its effect upon the efficiency of the whole, and the relative weight of such influence must, therefore, be carefully studied by the designer. That this fact is becoming more fully appreciated is evidenced by the increased attention now paid to that part of the steam plant which was formerly the most neglected,—the boiler. Safety, economy, and convenience in operation, and adaptability to the general requirements of the plant, are all now considered, and frequently to the exclusion of the question of mere cost, which, until recently, was the governing factor in the problem of boiler-selection.

If this problem has been solved in favor of the return tubular, or one of the usual forms of sectional boiler, the next step is to provide a setting which is efficient as a producer of combustion, durable under continuous hard firing, and capable of being quickly and cheaply repaired. To point out the lines upon which such a setting can be designed is the object of this paper.

The efficiency of furnace and setting depends largely upon correct proportioning of parts. Concerns selling boilers the acceptance of which is subject to the performance of some specified guarantee usually know from long experience the best proportions for the setting of their boilers; hence their advice should not be disregarded, except for forcible reasons. On the other hand, it must be remembered that a manufacturer will be reluctant to advise a detail which, though known to him to be the best, may, on account of increased cost, prevent him from making a sale. No amount of oversight can obviate occasional errors. The cheapest place to correct these is at the desk or drawing-board; hence it is good business policy to check up all the important dimensions before erection begins. The wide range of conditions encountered in practice renders it impossible to treat here every detail, irrespective of the kind of boiler and the circumstances under which it is to be operated, but the following discussion covers the most important details, especially of return tubular boilers, where no unusually novel conditions have to be met.

The grate area depends upon the height of chimney, kind of fuel,

and quantity to be burned per hour. Considering 30 pounds of water evaporated per hour as one boiler horse-power, and that one pound of coal evaporates from 10 to 7½ pounds of water, 3 to 4 pounds of coal per horse-power per hour must be burned. To provide for use of inferior fuel in emergencies, it is advisable to put this figure at 4 pounds.

Isherwood's experiments show that, with natural draft, the maximum number of pounds of average size anthracite that can be burned per square foot of grate per hour for chimneys up to 110 feet high is as given in Column II, Table I. These correspond very closely to the formula $W = 2\frac{1}{2}\sqrt{h} - 1$, in which W is pounds of coal per hour per square foot of grate, and h the chimney height in feet above level of grate; from this the other values of W up to h = 200 feet have been computed. For bituminous coals the maximum value of W is about $2.25\frac{1}{2}\sqrt{h}$, which gives Column III.

TABLE I.

MAXIMUM WEIGHT OF COAL BURNED PER SQUARE FOOT OF GRATE PER HOUR, WITH NATURAL DRAFT.

I. Chimney Height. Feet. h	II. Anthracite. Lbs. W	III. Bituminous. Lbs. W	I. Chimney Height. Feet. h	II Anthracite. Lbs. W	III. Bituminous. Lbs. W	I. Chimney Height. Feet. h	II. Anthracite. Lbs. W	III. Bituminous. Lbs. W
50	13.1	15.8	85	17.4	20.7	140	22.6	26.6
55	13.8	16.7	90	18.0	21.4	150	23.4	27.4
60	14.5	17.4	95	18.5	21.8	160	24.3	28.4
65	15.1	18.0	100	19.0	22.5	170	25.0	29.3
70	15.8	18.9	110	19.5	23.6	180	25.8	30.1
75	16.4	19.6	120	20.0	24.6	190	26.6	31.0
80	16.9	20.1	130	20.9	25.7	200	27.2	31.7

This table presupposes a chimney section equal to one-eighth the grate area,—a proportion which cannot usually be observed when a boiler is to be connected to a chimney already built. Further, the rates of combustion above given cannot be expected with the smaller sizes of coal, or when many boilers discharge into long smoke-flues. Not more than eighty per cent. of the tabular values, therefore, should be counted upon; hence the grate area will be

$$\frac{4 \times \text{Boiler Horse-Power}}{\frac{4}{5} \times \text{W from Table,}} = \frac{5\ \text{HP}}{\text{W}};$$

or, in words, multiply the boiler horse power by 5, divide the result by the appropriate tabular value, and the quotient is the required grate area in square feet. The tendency is to make grates too large; sizes obtained as above should not be exceeded, except on the advice of an expert. When either hard or soft coal is to be used under the same boiler, according to fluctuations in market price, the grate should be proportioned for anthracite. ' For wood the grate area

should be the same as for soft coal, but the furnace ought to be not less than 36 inches deep in order to permit carrying a fire 2 feet thick. Width of grate should be about equal to the diameter of the shell, and not more than 3½ feet of this width should be allowed for one furnace door. The most convenient distance between the grate or dead plate level and floor line is, for a man of average stature, about 26 inches, and a variation of over 4 inches on either side of this figure should not be permitted.

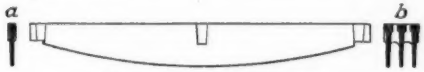


FIG. 1. SINGLE GRATE-BAR.

The clear space between grates and the shell or water tubes must be such that the air and gases can be thoroughly mixed and burned. A small distance permits the shell more readily to absorb the heat radiated from the incandescent fuel, but it cools the gases before combustion is completed, thereby causing smoke and waste. For anthracite a clear height of 2 feet gives the best results; less than 18 inches is hardly permissible. For ordinary bituminous coals 27 to 30 inches should be allowed; if the coal contains an unusually large percentage of volatile constituents, as much as 32 inches may be necessary, though in such cases it is better practice to spring a fire-brick arch over the top of the furnace. This prevents premature cooling of the gases, and facilitates combustion, so that a height of 18 to 24 inches will answer; but more should be provided, if possible. Where either hard or soft coal must be burned under the same boiler, a distance of 26 inches between the grate and shell is a good compromise.

All things considered, cast iron is the most suitable material for grate bars. The thin single bar *a* (Fig. 1) is the easiest form to handle, but is objectionable because it warps easily and renders the grate surface very uneven. It is better practice to cast the bars in nests of three, as in *b* (Fig. 1), which increases their resistance to warping sidewise, prevents the openings between nests from enlarging sufficiently to drop fuel into the ash-pit, and maintains a more satisfactory grate surface than can be expected with the single bars. The middle bar in a nest is usually made deeper than those on the outside.

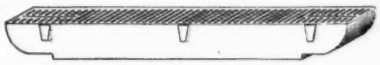


FIG. 2. SHEFFIELD GRATE.

The writer's experience has been that, with furnaces more than four feet deep, it is better to make the bars in two lengths, since those which run the full depth of the furnace are very heavy to handle, warp more easily than the shorter bars, and do not wear out evenly. The usual practice is to make the rear end of grates three or four

inches lower than the dead plate. No particular advantage is gained by doing this, while the bars are more apt to burn out near the bridge than when the grate is made level. It must be borne in mind that all cast-iron bars permanently elongate after being in service for a time; hence a clearance of one-half to three-fourths of an inch between the ends of the bars and the dead plate or bridge wall must be provided, when the bars are first put in place.

Experience seems to have demonstrated beyond a doubt that a total clear air-way between bars equal to twenty-five or thirty per cent. of the grate area is ample under all ordinary conditions, and much smaller areas have been used with excellent results. Some, however, advocate as much as forty-five or fifty per cent. of air-way, —an amount impossible to obtain with ordinary bars without providing between them spaces so wide as to permit a considerable quantity of fuel to drop through into the ash-pit. Such large air-ways can, however, be got by using a grate like the "Sheffield" (Fig. 2), or some of the herring-bone grates very similar to it. In these the short bars, or grids, can be made very thin with perfect safety, thereby enabling the increased air-way to be obtained.

Many forms of rocking, shaking, and dumping grates are offered in the market. Some of these, if under skilled management, are undoubtedly of value, but, considering them as a class, they are generally wasteful of fuel, and liable to get out of repair; hence the writer considers it only common prudence for the prospective purchaser to examine such grates in actual service with the kind of fuel he purposes to use, before deciding to employ them.

The bearers are also preferably made of cast iron. They should be as thin as possible, and the necessary strength should be obtained by increasing their depth. In furnaces five feet wide or more it is difficult to prevent the bearers from sagging under the heat, unless their depth is excessive. This trouble can be effectually overcome by screwing into the center of the bearer a leg, or support, made of 1¼-inch steam pipe.

Shallow ash-pits conduce to warping or burning out of the grate bars. Less than 18 inches between top of grate and bottom of ash-pit is bad practice; 24 to 26 inches is better. A greater depth holds out a temptation to let ashes accumulate, and defeats the very object for which it was provided. To cool the ashes and protect the grates the pit should contain several inches of water when the boiler is in operation. To provide for this, the pit bottom should be about six inches below line of ash-pit doors, level throughout, except where it slopes up to the doors, and constructed of a solid layer of concrete not less than six inches thick, made perfectly water-tight.

The bridge wall should be only high enough to mix the air and gases thoroughly and bring them into good contact with the shell. An opening over the wall equal to one-sixth the grate area is usually sufficient, but in no case is it advisable to make this area less than the total cross-section of the tubes, or to leave less than nine inches clear between the top of the wall and the lowest part of the shell. A smaller opening impedes the draft, concentrates the heat on too limited a portion of the shell, and increases the liability of burning the plates, if their inner surface becomes coated with scale.

The requirements for the space to the rear of the bridge wall vary according to the kind of fuel. With anthracite, combustion is practically completed in the furnace, so that, apart from convenience in cleaning, there is no necessity of making this space any greater than over the bridge itself. But with soft coals combustion cannot be completed in the furnace, and continues along the bottom of the boiler, and even into the tubes if the coal contain a high percentage of hydrocarbons. There will be less smoke and waste in proportion as the inflammable gases can be more thoroughly mixed with air, be kept from too close contact with the shell, which tends to cool the gases and extinguish the flame, and move at a relatively slow velocity until combustion has been completed. These results can be obtained in part by providing behind the bridge an open space, called the combustion chamber. A depth of 1½ to 2 feet below the grate level is sufficient for this space. Sometimes a depth of 6 to 7 feet is provided; this is overdoing the matter, and, besides, it increases the wall surface to be kept in repair, and augments the waste by radiation and leakage. A highly successful design, due to Mr. James I. Ayer, is shown in Fig. 3. In such constructions the height of the rear bridge wall should be determined in the manner already shown, while that just behind the grate is usually 3 to 4 inches lower. Fig. 4 shows the design advocated by the Hartford Steam Boiler Inspection and Insurance Company. This has proven satisfactory in service, is easier to clear than Ayer's arrangement, and I use it for anthracite and bituminous coals alike.

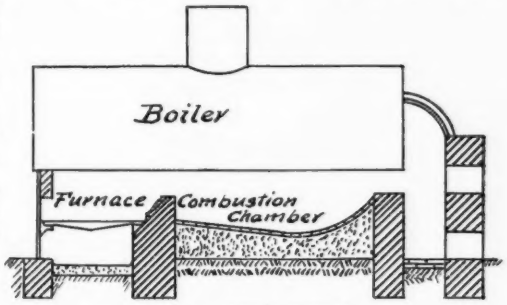


FIG. 3. AYER'S SETTING.

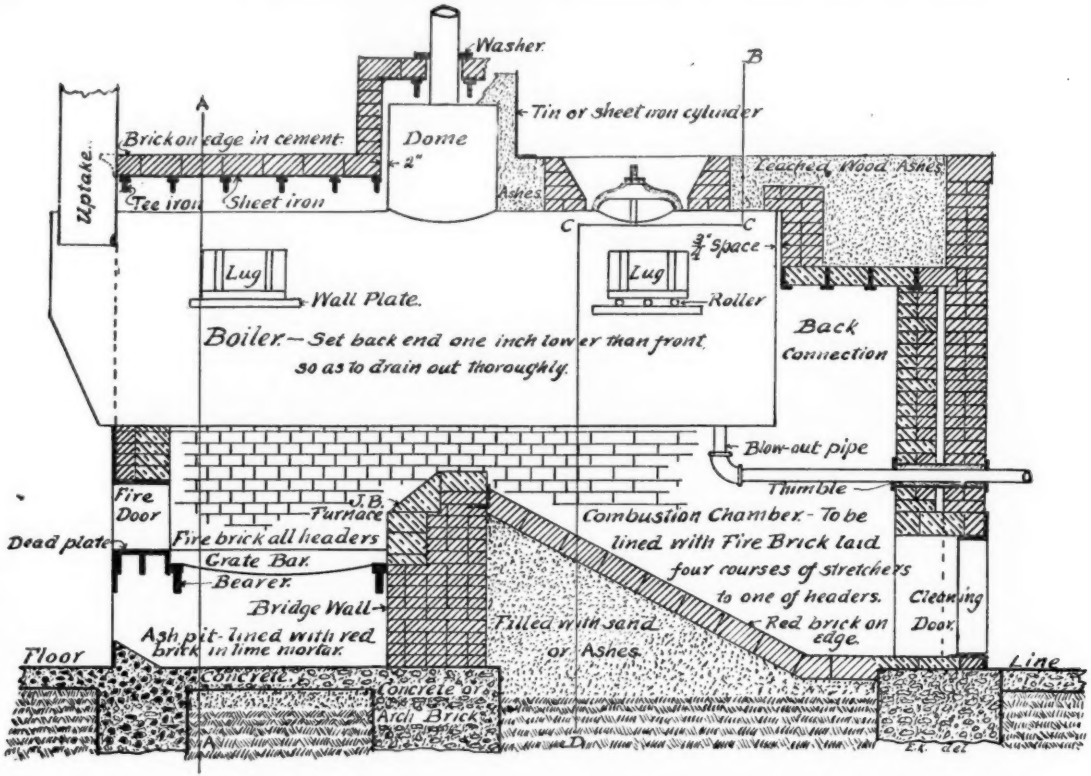


FIG. 4. LONGITUDINAL SECTION THROUGH SETTING. FOR TRANSVERSE SECTIONS SEE P. 595.

In the back connection the distance from tube sheet to rear wall of setting should be sufficient to enable a man to make repairs. It is difficult to swing a hammer in a space narrower than 28 inches; hence that dimension should be allowed, if circumstances will permit. The minimum area should be the same as that allowed for the uptake. An area not less than 10 per cent. in excess of that of the cross-section of the tubes should be allowed in the uptake, if it be fairly straight; otherwise, an excess of 25 per cent. is not too much. For sectional boilers this area may be taken at 1/6 that of the grate. In boilers with full flush fronts it is difficult to make a tight joint where the uptake connects wtth the setting; hence the overhanging front, in which the uptake is riveted directly upon the shell, should be selected.

At this point study of the constructive details should begin. Conditions essentially different from those governing ordinary masonry must be taken into account. Provision must be made for the entire structure to expand freely, without straining any part or causing fissures which may short-circuit the path of the gases, or permit infiltration of air. Perceptible settlement of any part of the structure must be guarded against, to insure an even distribution of the weight over the lugs or other supports. All parts subject to rapid deterioration must be capable of quick and cheap renewal.

A solid foundation is the first requisite, and excavation must be carried down until it is obtained. To guard against settlements the unit pressures on the foundation should be below the limit deemed consonant with safety in good building practice. Width of the wall footings is preferably such that the pressure per square foot will not exceed 4 to 5 tons on hard gravel and sand, 2 to 4 tons on hard, dry clay, dry, compact sand, or clay and sand, and 3/4 to 1 ton on wet clay or clay overlying quicksand. It is usual, however, to make the footings 8 to 12 inches wider than the superincumbent walls, except where they rest upon rock or hard, compact gravel. The liability of water leaking in under the foundation should be guarded against.

Where piling is not advisable, the most satisfactory method of dealing with very soft clay and quicksand is to place under the entire block plan of the boiler a sheet of well-rammed concrete, into which are embedded pieces of old rails laid at right angles to the axis of the boiler. From the footings up to the floor-level the walls should be built of good arch brick, and in the remaining portions only the best uniform-sized red and fire-brick should be employed.

The great range of temperature between the external wall and the furnace interior renders it practically impossible to keep tight any setting not built with separate inner and outer walls. The usual practice is to support the boiler by lugs resting on the inner walls. For

reasons presently to appear, the writer's custom is to carry the weight of the boiler and covering wholly on the outer walls, making them not less than thirteen inches thick, except in the rear of boiler. The inner walls are then reduced to a thickness of nine inches, and are so designed that they can be entirely torn out and replaced, without the necessity of blocking up the boiler and encroaching on the already cramped space available for making repairs. Further, not more than two lugs built into the brickwork should be placed on the side of a boiler; there is no difficulty in so designing these that two on a side are ample for any boiler not more than twenty feet long. A third one in the center is only a delusion. When firing begins, the bottom of the boiler expands more than the top; the two end lugs are raised from their seats, thereby frequently cracking the walls and always throwing the weight of the boiler and part of the masonry on the central lugs. Hence the latter are a source of danger rather than benefit.

The lugs should bear on a cast-iron plate about 1 foot long and 1½ inches thick, with reasonably plane surfaces to prevent the lugs from resting on one of their corners. Three one-inch rollers should be put between the rear lugs and their wall plates, and the latter are better if faced off true on top. It is useless to expect rollers to protect the wall from cracking, if the brickwork is laid up solid around the lugs in the usual way. The writer's custom is to leave a clearance of three-quarters of an inch between the masonry and sides of all lugs, and then form in the wall a pocket over which are placed some pieces of bar iron to support the upper wall. The space between the ribs of the lugs is then filled flush with masonry, and a piece of tin, built into the wall directly over the iron bars, extends out over the lugs, and prevents ashes, sand, or other filling from working down under the rollers (see Fig. 5). Each lug can then move in its pocket with perfect freedom.

Buckstaves should be put opposite the wall plates and along the other parts of the wall, at intervals not exceeding four feet.

The fire-brick lining is almost invariably bonded in with the red-brick walls, and is frequently stopped off several feet beyond the bridge wall. The writer believes it is true economy to line the entire inner walls with fire-brick; such procedure is imperative in many parts of the northwest, where the common brick rapidly crumble under even a moderate heat, if long continued.

Fire-clay has two serious defects; its cementing quality is slight, and it shrinks considerably in drying. Hence a wall built with it is naturally weak, and, if bonded in with red brick laid up in mortar, the fire-clay joints dry out more or less loose. Hence, when fire bricks in the furnace are laid mostly stretchers, the life of the lining

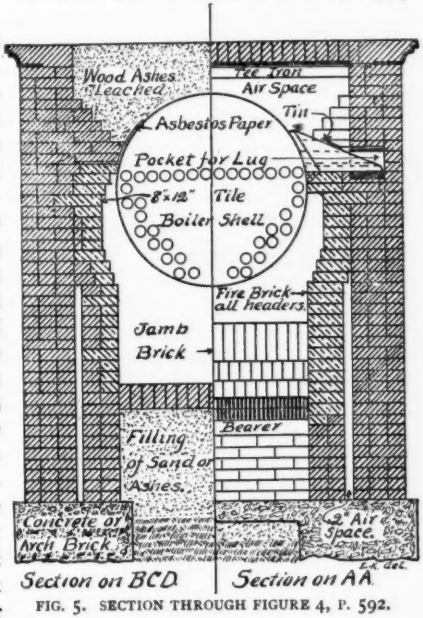


FIG. 5. SECTION THROUGH FIGURE 4, P. 592.

is short, because the shocks caused by detaching clinkers, and the gradual thinning of the wall through wear, cause the brick to fall out. The only method known to the writer whereby the shrinkage can be overcome is to use, in place of clay, a mixture of one part by weight of clay with three parts of pulverized fire-brick screened through a sieve with not less than forty meshes per inch. This combination shrinks very little. To increase the cementing qualities, slack into this mixture three per cent., by weight, of lime; this proportion has just sufficient action as a flux to fuse the whole together into a solid mass. It will increase the strength of the walls, and is particularly desirable when constructing fire-brick arches. The writer thinks that, even when this mixture is used, it will save money in the end to line the furnace up to 2 feet beyond the bridge wall with solid fire-brick laid all headers, with a 2-inch air-space between them and the outer wall, as shown in Figs. 4 and 5. Benezet or Savage fire-brick should be used for this lining, and neither here or elsewhere should any cut surface of the brick be exposed to the hot gases. The remaining parts of the inside wall may be built of a cheaper grade of fire-brick laid four courses of stretchers to one header and backed up with red brick. The walls should close in on the boiler at a point not higher than the bottom of the upper row of tubes. To provide the space necessary for cleaning, circulation of gases along shell, etc., the wall should be stepped back at the top, as in Fig. 5. Where rivets and edges of plates are met at the closing-in line, the bricks should be set back enough to let these pass during expansion of shell without catching on any part of the wall. The large tiles shown under the corbeling below the closing-in line are not absolutely necessary, but are advisable in order to support the upper part of the wall when the lower part is torn out. A lining thus constructed will last far longer than

the usual form, and the ease and rapidity with which it can be renewed are evident. Even the fire-brick ends from furnace headers can be used for repairing the rear walls.

Falling out of bricks from around the fire doors is an aggravating nuisance. To prevent this, the crown and jambs should each be formed of a solid piece of specially-moulded fire-brick ; else some efficient design of cast-iron frame must be employed. The common rectangular door-casing, in which the jambs and crown are cast in one piece, will almost invariably sag in the center of the crown, and drop out the brick about it. Fig. 6 shows a design that the writer has used for six years with excellent results. The parts can expand independently, and up to the present not one of these cast-iron arches has shown signs of failure.

The top of bridge wall may be either an inverted arch, or flat. The former is more difficult to construct well and keep in repair ; hence it is rapidly dropping out of use. The latter form is especially preferable when ducts have to be built into the bridge to convey the extra supply of hot air necessary to consume the gases from coal having a large content of volatile matter. Even with a flat wall the erosion of the gases and occasional knocks from firing tools or logs of wood are liable to loosen the joints in the top course of brick. It is, therefore, good practice to cap the wall with 8 × 12-inch jamb tile on edge, bevelled off in front to facilitate cleaning. To prevent these from getting knocked out of place, an old bearer, or piece of angle iron, should be built in behind the wall, particularly where cord-wood is used for fuel.

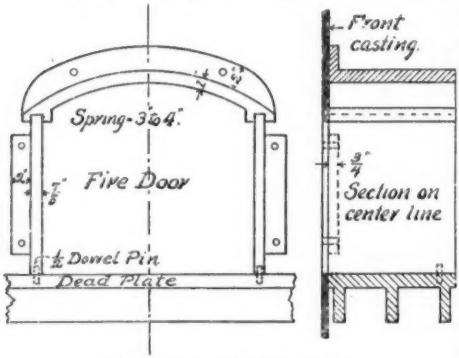


FIG. 6. FIRE DOOR AND CASING.

The back connection is preferably covered in by a flat roof about an inch above the top row of tubes. This form is easiest to repair, and gives more room inside for rolling leaky tubes, etc. It should be constructed of fire-brick laid between the stems of cast-iron T-bars, which extend clear through to the outer walls, so that they can support the roof when the interior walls are entirely torn out. No matter what form of roof be used, it must be stopped off at least three-

quarters of an inch from the tube sheet, to allow room for the boiler to expand, and be carried up to the exact contour of the top of the shell, so that the boiler covering can be carried over it.

The top of the boiler is usually protected by a filling of sand, or a brick arch turned over the shell. Both of these materials are objectionable, owing to their high conductivity for heat. Brick is further objectionable, because, when it rests upon the shell, it moves with the latter, thereby causing fissures between the arch and side wall, and roof over back connection. If a brick arch is wanted, it should have a layer of sand an inch thick between it and the shell, and a clearance of an inch should be left between the masonry and the dome, nozzles, etc., to be afterward filled in loosely with mineral wool or fire-clay. Better results can be got by using some of the specially-made boiler coverings, which are superior as heat insulators, and permit the shell to slide under them without causing breaks in the covering. Confined air is one of the very best insulators; hence an excellent plan is to span the entire space over the boiler with light T-iron, lay on this some sheet metal, and cover the whole with brick on edge in cement. An opening provided with proper cover must be left over the man-hole, and the necessary clearance around nozzle, etc., should be closed by a washer fitted around the pipe. If a dome is attached to the boiler, the brick work should be continued up around it and closed over the top as before, leaving everywhere an air space not less than two inches wide between the shell and inner face of the wall (see Figs. 4 and 5). Objections to this plan are the extra height of setting required and the difficulty of getting access to the top of the shell for inspection or repairs.

When wood fuel is used, a covering more satisfactory than any other which the writer has employed is obtained by carrying the walls up to eight inches above the highest point of the shell, and filling in the whole space level with thoroughly-leached wood ashes. On no account should unleached ashes be used, since serious corrosion will result if any moisture gets between the ashes and the shell. The high efficiency of this covering is apparent from the fact that, considered as heat insulators, the relative values of wood ashes, sand, and brick are as 61 to 17 to 7. A further point in its favor is the ease with which the shell can be uncovered at a trifling expense, and the same filling be put back again when the repairs, etc., are completed.

The nearly obsolete custom of carrying the waste gases over the top of the shell seems to be reviving. While this practice is not so objectionable in case of hot-water boilers, it should not be tolerated in any steam boiler, for reasons thus set forth by the Hartford Steam Boiler Inspection and Insurance Company. "If the setting becomes

shaken so that the side walls become separated even but a slight distance from the shell, then trouble begins, for the fire will take a short cut up the sides of the shell into the overhead flue, it being the most direct route to the chimney, and, in addition to destroying the efficiency of the boiler, the shell will always be burned, unless it is very soon attended to. With some waters also, even when the setting is in perfect order, there will be just enough heat passed over the top of the shell to cause the most astonishing amount of corrosion in the steam space, the writer having seen boilers running less than a year, with the shells eaten fully half way through by actual measurement, due to this cause alone; while in the same room, and running under exactly the same circumstances otherwise, with the exception that there was no flue over the top of the shell, were other boilers which had been running for fifteen or sixteen years, and were perfectly sound. Of this setting we can only say we see no advantage to be gained by adopting it, while there is a chance that serious damage may be done." Further, any possible small efficiency gained at the start is usually soon lost by accumulations of ashes and soot on the shell where it forms the bottom of the flue.

Pipes passing through the side walls should be avoided, if possible. The feed is preferably taken in at the top or front, and, where the blow-out pipe or returns from heating systems pierce the rear walls, they should pass through a thimble of larger pipe built solid into the wall. The annular space between the two should be packed with mineral wool, or asbestos fiber, and be stopped off at each end with a washer secured to the thimble. Mud drums should be so placed that their axis is parallel to the axis of the boiler. If set at right angles to boiler, with ends projecting through the side walls, the expansion of the boiler must necessarily crack the brick work around the drum, and greatly increase the air leakage. Badly-fitting cleaning doors are also sources of large air leakage. These doors should be ground to a close fit, or be provided with asbestos washers and a strong clamp handle, so that they can be drawn up tight. If exposed to strong heat, they should be provided with an inner baffle plate, or a lining of fire-brick, to prevent warping. Doors into the front and uptake should also be ground to a good fit.

Every precaution must be taken to prevent water from leaking into the setting. Escapes from safety-valves should be piped off beyond the setting walls, and liability of leaks from defective pipe joints—flanged joints in particular—should be guarded against.

The highest grade of masonry is essential, if the setting is to be durable. If the design herein advocated is adopted, the entire outer walls are preferably laid up in cement. In any case cement should be

used for all parts below the floor line, and the last foot of height of the outside walls. Lime mortar should be allowed to sour at least three weeks before working up, or it will crumble under action of the heat. Thin joints are imperative. Those between the red brick should not exceed five-sixteenths of an inch. Satisfactory results can be expected from fire-clay only when it is thin enough to be poured with a cup; each brick must be rubbed into place and firmly driven down with a mallet, until it bears on the one below, leaving between them only sufficient clay to fill the interstices due to irregularities of the brick.

The ruling custom is to block the boiler in place, and then erect the masonry around it. An objection to this plan is that a man can do neither the quantity or quality of work that would be possible in less cramped working quarters. The writer has, therefore, found that, when sufficient head-room is available, it is advantageous to lay down a complete detail-drawing of the entire setting, construct the masonry up to the level of the lugs, allow the walls to dry, and then move the boiler into its final position. The increased expense of handling the boiler is usually more than made up by the saving in bricklayers' time and the superior quality of masonry obtained.

No matter how well the walls are built, it will be difficult to keep them tight and make extensive repairs cheaply when the weight of boiler and covering rests upon the masonry. The practice of hanging shell boilers on steel frames independent of the masonry, in accord with standard practice in setting water-tube boilers, is, therefore, on the increase. It saves considerable masonry and space, makes a much neater construction, and dispenses with buckstaves.

Accessibility of all parts is essential to efficient operation, and to prompt action in times of danger. Ample room should be provided in front of boilers for handling fuel and ashes, and for working a tube-scraper. The clear space between the rear wall of the setting and the side of the building should be such as to afford ready access to cleaning doors, space in which to do pipe-fitting, etc., and in a large plant there should be two passages connecting this rear space with that in front of the boiler.

In the average steam plant the boiler is even yet the last member to receive adequate attention in regard to such small details as have been discussed. Too frequently the setting is left to men whose only qualification is their ability to lay brick and willingness to accept low wages. No successful plan has yet been evolved whereby it is possible to obtain something from nothing, while those who wisely expend at the start the money and brains necessary to secure efficient and durable construction find that, during the life of the plant, their investment is returned to them many fold.

THE BUSIEST CANAL IN THE WORLD.

By Wm. P. Kibbee.

THE chain of great lakes in which the two peninsulas of Michigan are situated covers an area of 90,300 square miles, and constitutes more than one half of the fresh waters of the globe. With the exception of Ontario, the borders of Michigan are washed by the waters of all these lakes, five in number, which, by their depth, magnitude, and extent, give her an advantage that no other inland State can hope to enjoy. At its southeastern extremity the State is touched by the waters of Lake Erie, a body of fresh water two hundred and twenty miles in length and forty-eight in width, and with a maximum depth of about two hundred and four feet. Its height above tide-water is about five hundred and sixty-four feet. Connected with this by the Detroit river is Lake St. Clair, a shallow body of water, eighteen miles in length by twenty-two in breadth, and having a depth of twenty-four feet, and an elevation of five hundred and seventy feet above the ocean. Thence, by a second strait, the St. Clair river, we pass to the north upon the bosom of the Lake of the Hurons,—a lake which abounds in the finest of trout, and is seldom, according to the traditions of the Indians, visited by severe storms. Lake Huron, which forms the eastern boundary of Michigan, separating it from the province of Ontario, is two hundred and fifty miles long, with an average breadth of about one hundred miles, a depth of about nine hundred feet, and a height above tide-water of five hundred and seventy-four feet. Its superficial area is about 20,400 square miles. Connected with this by the straits of Mackinaw, which separate the two peninsulas, and extending southward nearly parallel with it, and thus forming the entire western boundary of the lower peninsula, is Lake Michigan. This great body of water is three hundred and twenty miles in length, eighty in width, and eight hundred and forty feet in depth, and its surface lies five hundred and eighty-seven feet above tide-water. It has a superficial area of 22,400 square miles. Green Bay, an arm of Lake Michigan, so important to the shipping interests of the northwest, is one hundred miles in length and twenty in breadth, with sufficient depth for navigation. If, instead of passing westward through the beautiful straits of Mackinaw into Lake Michigan, we continue northward from Lake Huron through the Hay Lake channel and between the shores of the St. Marie, avoiding the Sault by availing ourselves of the magnificent locks which the government has finally completed, we enter upon the surface of the southwestern

extremity of "Gitchigamme"—Lake Superior. This, the greatest body of fresh water found upon the earth, is three hundred and fifty miles in length, one hundred in breadth, eight hundred and seventy-eight feet in depth, and six hundred and twenty-seven feet above tide-water. It covers not less than 100,000 square miles of surface. This immense shore line, and the numerous streams emptying into it, have been the greatest means of settlement in the northwest, by rendering all parts of it so accessible. The immense forests of pine, otherwise unavailable, are, through this magnificent water-communication, readily attacked; the logs in vast quantities are floated down the streams to the mills at the mouth of the great rivers on the lake shore,

THE RAPIDS OF THE ST. MARY'S RIVER.

where they are cut into lumber, which is loaded into vessels and transported to different ports.

The ores of the northern peninsula of Michigan, of which so great a quantity is now annually mined and shipped away, would be of little or no value, were this chain of navigable waters to be removed.

The broad, deep bodies of water lying upon either side of the lower peninsula are the great modifiers of its temperature. They are reservoirs of the summer's heat, which is slowly given up again during the cold season, tempering the bitter blasts and depriving them of their killing power.

THE EXIT FROM THE NEW AMERICAN LOCK.

The terrible storms from the northwest that sweep over the open waters of Lake Michigan mingle with the vapor ever rising from its bosom, and, thus modified, they reach the borders of Michigan no longer endowed with the power to destroy. From this cause the western border of Michigan has become known as the fruit-belt, a region where many of the choicest fruits are largely and profitably cultivated.

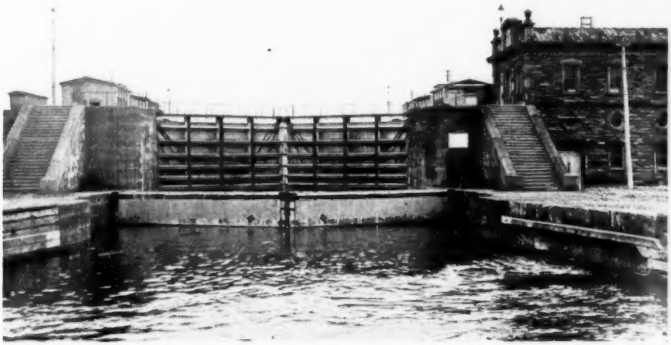
The upper peninsula of Michigan, made famous for the quality and extent of its minerals, is for the most part mountainous, though presenting a kind of scenery peculiarly magnificent. The outlying country of lower Michigan may be described as swelling into gentle

THE UPPER END OF THE AMERICAN CANAL.

hills and undulations, covered with forests of heavy timber, or groves of oak, which seem like natural parks, or expanding into rich prairies or crystal lakes.

The first settlement in Michigan was made by the French at Sault St. Marie, in 1608, and from a mere trading-post in those days it has become one of the most conspicuous points in the great avenues of commerce between the great lakes, and nucleus of the grand procession of stately steam and sailing craft to and from the northwest.

The city of Sault St. Marie offers much of historic interest. It is built on a level, and immediately alongside the government locks and canal. Fort Brady, the government's strong-hold at this point, occupies a commanding position on a hill overlooking the city and canal, while running through the city proper is a water-power canal, two miles long, that for some reason failed of its purpose. The population is



LOWER APPROACH TO THE CANADIAN LOCK.

about five thousand, mostly whites, and the few Indians that are left earn a livelihood by hunting and fishing.

Directly across the lake stands the Canadian Sault, where is situated the new lock built by the Canadian government at a cost of $4,000,000. The two towns, with their environs, are usually comprehended under the one name of Sault St. Marie.

In the early days, when the fur trade was the predominating industry in the region of the great lakes, the Sault, as well as the island of Mackinaw, were the most important stations of the Hudson bay and American fur companies. On the annual return of the fleets, and the assembling of the Indians for traffic, this rendezvous became a scene of great animation; the transparent waters were dotted with canoes and *bateaux*, merchants, traders, *voyageurs*, and gaily-bedecked savages, coming from every quarter.

Originally, the only means of access to Lake Superior was over the rapids, which were so shallow and rocky as to admit of no craft drawing more than two feet of water, and even such craft found shooting these foaming billows very dangerous.

When the great copper and iron mines were discovered on Lake Superior, it soon became evident that a lake communication with the east was all that was lacking to rank these mines among the greatest producers of their respective ores in the world.

To obtain a continuous route to the lower lakes it was necessary to build a canal, lock, and channel, reaching from the southern extremity of Lake Superior to the north shore of Lake Huron.

Lake Superior being twenty feet higher, mean level, than the lower lakes, it was necessary to construct a lock, by which vessels might be raised or lowered to a position corresponding with the levels of Lakes

STEAMER NORTH WEST ENTERING THE AMERICAN LOCK.

Superior and Huron, by way of the Hay Lake channel and Mud Lake, or of Little Lake George, as the case might be.

By an act approved August 26, 1852, congress granted to the State of Michigan 750,000 acres of land, to be used to pay for the construction of a ship-canal around St. Mary's falls. The State legislature accepted the grant, and authorized the governor to appoint commissioners to contract for the work and to enter the lands authorized by the grant. In consideration of becoming possessed of the entire body of lands donated for the purpose by the State, the work of constructing the canal was undertaken by a number of eastern capitalists, and the first ground was broken on June 4, 1853. Its prosecution was attended with considerable difficulty; but the canal was finally completed and opened to the public in June, 1855,—two years from the date at which the work was begun.

COPPER-LADEN VESSELS PASSING THROUGH THE AMERICAN LOCKS.

It soon proved inadequate to the wants of commerce, and its enlargement was undertaken by the general government, and carried on through many years, until its completion. Commerce and civilization have long since spread over the entire northwest. The paddle of the savage is supplanted by the powerful wheel of the steamship, and the *bateau* of the *voyageurs*, which bore away the fur of the beaver, is displaced by innumerable vessels loaded with the products of the farm, the lumber-camp, and the mine ; but Sault St. Marie retains much of the importance which it held two centuries ago. It must not be understood that the multitude of steam and sailing vessels really center there. They are passing up and down continuously, and with a regularity that

EIGHTEEN-HOURS' BLOCKADE IN THE SAULT CANAL, ON ACCOUNT OF DAMAGE TO THE LOCK.

is amazing,—about sixty-five vessels of all kinds each day, on an average. The writer witnessed in 1890, when the gates refused to open, a procession of stately craft three miles long waiting to be locked through. The following figures give some conception of the business handled at this canal. Number of vessels locked through during the fiscal year 1895, 17,956. Registered tonnage, 16,806,781 tons.

Total amount of freight, 15,062,580 tons; valued as follows:

Coal (hard and soft)	$ 6,993,351
Flour	33,383,632
Wheat	30,041,863
Grain other than wheat	4,164,347
Manufactured iron	3,683,150
Pig iron	346,788
Salt	202,439
Copper	21,490,400
Iron ore	22,332,319
Lumber	8,888,400
Silver ore and bullion	11,200
Building stone	238,760
Unclassified freight	27,798,480
Total	$159,575,129

The new lock, which was opened a little less than a year ago, and is considered the finest piece of canal engineering on the great chain of lakes, has a clear length between gates of eight hundred feet, and a width of one hundred feet. When the water is at its normal stage, vessels drawing twenty-one feet of water can pass through with well-ordered safety. The walls on each side of the new lock are 1,100 feet long, while from the east end, for 282 feet, the walls are 45 feet high.

THE FORMAL OPENING OF THE NEW LOCK.

INTERIOR OF THE NEW AMERICAN LOCK.

and from that point westward 43 feet high. At the base the walls are 20 feet wide, this width continuing for 10 feet, when, by five 2-foot offsets, 5 feet apart, they gradually narrow to 10 feet in width. At both upper and lower ends the walls are 36 feet wide from base to summit. The walls are faced with the best Kelly Island limestone, which was transported to the Sault in the rough. The facing of the lock wall consists of twenty-three courses,—*viz.*, courses two to twenty-two, having stones 6 feet long, 3 feet wide, and 2 feet thick; part of the initial course; and the coping course, being 1½ feet thick. The cost to the United States for the masonry alone was $1,085,469.

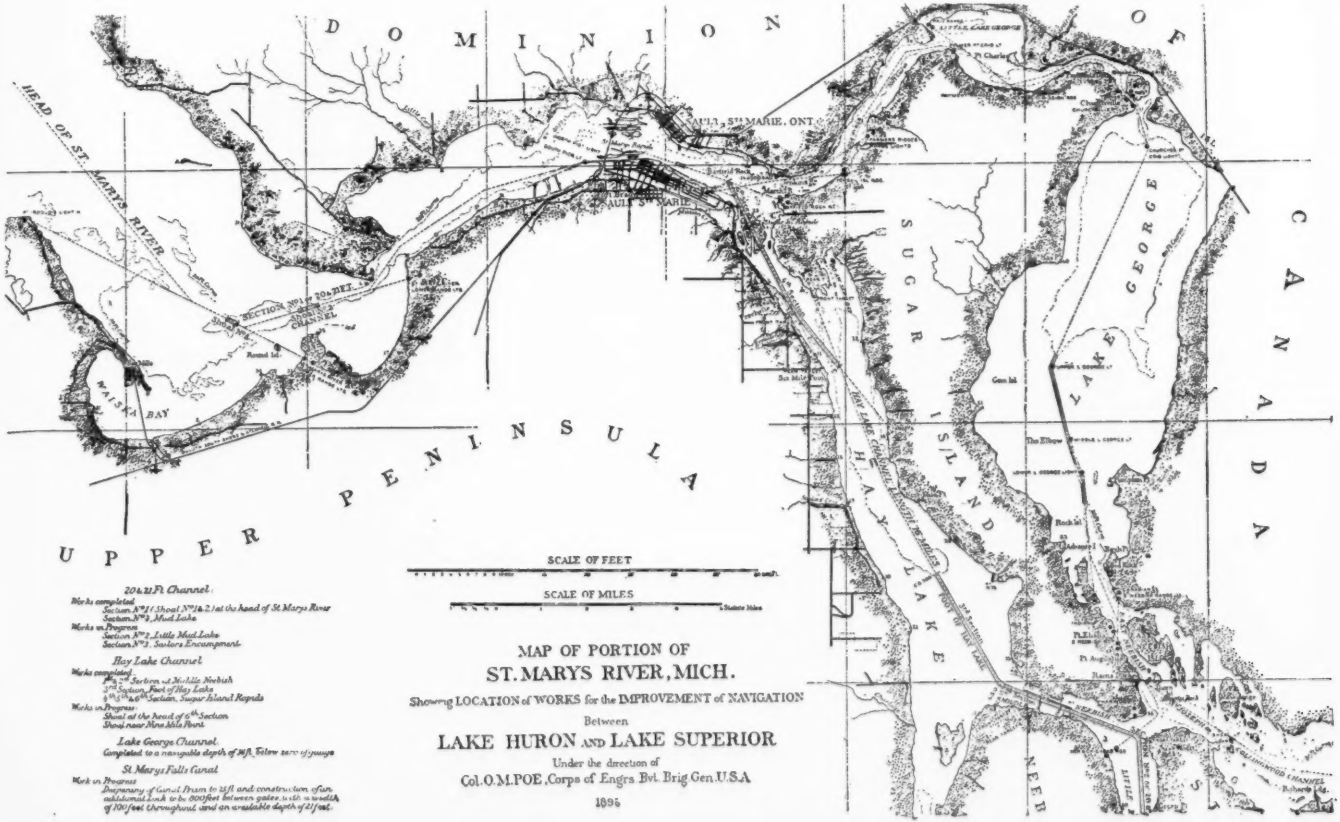
The new lock is equipped with five gates, constructed wholly of steel, which were put to the severest test before acceptance. They are known as the upper guard, upper lock, intermediate lock, lower lock, and lower guard gates. In dimensions the upper guard and upper lock gates are 26 feet 6 inches in height; the lower and intermediate gates are 43 feet high; and the lower guard gate is 25 feet 6 inches from base to top. All the gates are uniform in length,—55 feet,—and are the largest steel gates in the world. Each leaf of the smaller gates weighs in the neighborhood of 100 tons, while those of the larger ones weigh 190 tons respectively. Each leaf is supplied with two air-pumps and air-chambers, stationed at a point near the base of the gates, while the two water-chambers occupy a position above the center. To retain the equilibrium of the gates and to conquer superfluous strain upon the quoin posts, these air- and water-chambers are used in conjunction very advantageously. The air-pumps are operated by human power from the tops of the gates. The cost of the gates, with the anchorages, was $203,000, and they were built in Detroit, Mich.

PASSENGER STEAMERS BEING LOWERED INTO THE ST. MARY'S RIVER.

The immediate machinery of the lock is divided into two separate and distinct plants,—the operating plant and the pumping plant. The former consists of six machines that operate the gates. Twelve engines open and close the valves, by means of which the chambers are filled and emptied, and two hydraulic capstans, with the pumps, accumulators and piping, complete the lock operation.

There are two capstans, one at either end of the lock on the south side. In appearance they are similar to the ordinary naval capstan. These capstans are driven by three single-acting, oscillating, hydraulic engines, each of which is designed to develop a pulling-power of 19,000 pounds. The capstans are for use in assisting vessels through the lock when not provided with power of their own.

THE CANADIAN LOCK, SAULT ST. MARIE, ONTARIO.



20½ Ft. Channel:
Works completed
Section N°1 Shoal N°1 & 2 at the head of St. Marys River
Section N°4 Mud Lake
Works in Progress
Section N°2 Little Mud Lake
Section N°3 Sailors Encampment

Bay Lake Channel
Works completed
N°1 Section at Neebish
N°2 Section, East of Hay Lake
N°3 & 4th Section, Sugar Island Rapids
Works in Progress
Shoal at the head of 4th Section
Shoal near Nine Mile Point

Lake George Channel.
Completed to a navigable depth of 18 ft. below zero of gauge

St. Marys Falls Canal
Work in Progress
Deepening of Canal Prism to 22 ft. and construction of an additional Lock to be 80 ft. between gates with a width of 100 feet throughout, and an available depth of 21 feet.

MAP OF PORTION OF ST. MARYS RIVER, MICH.

Showing LOCATION of WORKS for the IMPROVEMENT of NAVIGATION Between

LAKE HURON AND LAKE SUPERIOR

Under the direction of
Col. O. M. POE, Corps of Engrs. Bvt. Brig. Gen. U.S.A.
1896

The operating machinery was designed in the United States engineer's office at Detroit, and cost $60,000. The gate machinery differs entirely from any at present in use, in that it represents a combination of hoisting machinery and highest English hydraulic practice. The pumping machinery, whose sole duty is emptying the lock in case of accident to the gates, is placed in the basement of the power house, and consists of three centrifugal pumps, each having a discharge of thirty inches in diameter. The driving-power consists of three Westinghouse engines of 350 h. p. each. The steam is furnished by a battery of water-tube boilers, set in steel cases. The machinery, which was designed by J. Kennedy, of Pittsburg, is said to be capable of emptying the lock in seven hours.

The lock chamber can be filled and emptied in seven minutes. The water is let into the lock through six culverts, which run longitudinally below the lock floor.

The office and power-house are built of cut stone, and alone represent an outlay to the government of $100,000. The whole work completed will cost the government $5,000,000.

Work on the new lock was commenced in May, 1887. The lock was formally opened to traffic August 3, 1896, when the river and harbor boats, the Hancock, of Detroit, and the revenue cutter, Andy Johnson, passed through. The opening was suitably observed by the salute of one hundred and twenty-six boats, which were in port, and continuous whistling was kept up for fifteen minutes.

Average time occupied in making a lockage, 40 minutes.

Cost per lockage, $7.89.

Cost per passage, $3.34.

The new canal and locks built by the Canadian government, and which were opened to the craft of any nation flying a peaceful flag, went into commission shortly before the American locks were opened. The Canadian locks are directly opposite the American Sault, and have an advantage that any person versed in naval affairs may readily understand. Prior to the completion of this canal, all Canadian craft doing business along the shores of Lake Superior were compelled to pass through the American Sault. The completion of the canal enables them to pass to and from Lake Superior through a waterway exclusively Canadian. I shall not touch upon the design or construction of this lock, other than to say that it is built after the plan of the American locks, and is perfection.

Much trouble, however, was experienced early in the work by a series of cave-ins of the masonry. This has now been remedied, and the lock is as substantial a structure as could be wished for. The cost of this work to the Canadian government was about $4,000,000.

REVIEW OF THE ENGINEERING PRESS

American Ship-Building and Shipping.

THE views of one of the most famous ship-builders in the United States upon the present status of American ship-building and shipping, cannot fail to be interesting, though we need not at all adopt his point of view nor accept his conclusions as to policy. The interest is heightened when his views and principles are contrasted with the clear and vigorous paper by Capt. John Codman, which appears in the leading pages of this issue. Charles H. Cramp, in a paper read before the senate committee on commerce (April 7), and reported in *Iron Age* (April 15), maintains that "no nation can either build or own ships, when, unprotected and unencouraged, it is brought in competition with other nations that are protected and encouraged." He asserts "that the enormous revenue represented by the freight and passenger tolls on our commerce and travel is constantly drained out of this country into British, German, and French pockets, in the order named, but mainly British; while the vast industrial increments represented by the necessary ship-building inure almost wholly to Great Britain. For this drain there is no recompense. It is sheer loss. It is the principal cause of our existing financial condition. So long as this drain continues, no tariff and no monetary policy can restore the national prosperity. Until we make some provision to keep at home some part at least of the three hundred and odd millions annually sucked out of this country by foreign ship-owners and ship-builders, no other legislation can bring good times back again. It is a constant stream of gold always flowing out." The author argues that the United States is, by the folly of its own people, reduced to a state of financial and industrial subjugation to England. "Great Britain has many out-lying colonies and dependencies. The greatest two are India and the United States. She holds India by force of arms, whereby her control of that country costs her something. She has to pay something for her financial and commercial drainage of India. She holds the United States by the folly of its own people, whereby her control of this country costs her nothing. . . . The amount of her annual drainage of gold from the United States far exceeds that from India. Therefore, the United States is by far the most valuable of all the dependencies of Great Britain. In the relation of England to India there is something pitiable, because India is helpless. In the relation of the United States to England there is nothing that is not contemptible, because it is the willing servitude of a nation that could help herself if she would." Figures are given by Mr. Cramp to indicate the enormous efforts that England is making to conserve her supremacy of the seas. "England, clearly seeing that, in this age more than ever before, ocean empire is world empire, strains every nerve to perpetuate her sea power, and exhausts her resources to doubly rivet the fetters which it fastens upon mankind. Since 1885 England has expended $517,000,000 for new ships of war and their armament. During eleven years she has built 38 first-class battle-ships, 3 second-class battle-ships, 9 armored cruisers, 20 first-class cruisers, 51 second-class cruisers, 33 third-class cruisers, 30 gunboats, 12 composite sloops, and 74 torpedo-destroyers, including the vessels authorized in the current year's programme. The aggregate is 270 vessels of 1,136,575 tons' total displacement, 1,674,700 h. p. Of the navy England already had in 1885 there remained available 42 armored ships, 34 cruisers, 11 sloops, 19 gunboats, and 95 torpedo boats, which she is re-engining, re-arming, and otherwise modernizing as rapidly as she can. In *personnel* afloat she has augmented her force from 52,600 in 1885 to 100,500 in the estimates for 1897. In other words, England has doubled her navy in *personnel* and material, and more than quadrupled

it in war-like efficiency, during eleven years of the profoundest peace the world ever saw." Mr. Cramp shows that England has, in 1896, made a practical addition of 1,370,000 tons to her merchant marine. He attributes this effort on the part of England to the alarm induced by the efforts of Germany to increase her naval power, and the additions which the United States have recently made to their naval force. He states with great positiveness that England "has determined that she shall be not only the supreme sea power, but also that, except within limits set by herself, there shall be no other sea power at all. . . . The moment any other national aspiration towards sea power reaches the point at which it begins to affect her naval supremacy or dispute the ocean monopoly of her merchant marine . . . England will crush it by intrigue, by cajolery, by treaties, if she can. She will crush it by preponderating force, if she must." It is charged that England has dealt with the utmost unfairness with the two first-class American ships put in the trans-Atlantic trade under American management. "Every resource that unscrupulous rivalry can suggest has been exhausted by the English press and the English administration to defame and discredit them. English officials abroad, from ministers and consuls down, industriously reproduce in the newspapers of Japan, China, Chili, Argentine, and Brazil the misstatements of the English press about American vessels. The British post-office delays the American mail for days in the slower ships of the Cunard line rather than send so much as one letter by the American line. Our post-office responds by liberal allotments of its European mail to all the British lines. The result of all this is that, while this country has never known such industrial stagnation and such financial distress, England has never known such industrial activity or financial prosperity as now."

Congressional Regulation of Railway Traffic.

On general principles we do not attach great importance to the views of secluded professional men upon the practical questions of active business. By "secluded" men we mean men who, like professors in collegiate institutions, are mostly shut out from participation in the active affairs of business, and who, from the very nature of their occupations, are brought into contact chiefly with theoretical principles apart from the limitations and restrictions which practical men encounter in the application of theory to human affairs. This is not said in derogation of theoretical principles or the men who devote their lives to their study. The latter are among the most useful of mankind; for it is entirely certain, notwithstanding what we have said above, that successful practice cannot cut loose from sound theory, and that the latter must be regarded in obtaining a proper comprehension of its practical limitations, to say nothing of the application of the knowledge thus gained to practical affairs. For this reason we are not surprised that the paper read by Prof. Howard S. Abbott, of the University of Minnesota, before the national convention of railroad commissioners, at St. Louis (May 11), fell, apparently, rather flat, notwithstanding its literary and historical value. The paper, reported in *The Railroad Gazette* (May 21), is valuable historically as a review of legislative action upon the subject in the United States since the foundation of the republic, and probably most students of economics will agree with the author upon the general proposition that "the causes producing unjust discrimination will be found to consist of economic laws and conditions and the selfishness of human nature." But how is legislation to intervene successfully between these antagonistic forces? This is a question upon which the widest differences of opinion may and do exist, not only among theoretical, but among practical, railroad men, and particularly between these two classes of thinkers, the former class being apt to underrate practical obstacles to the practice of theory, and the latter being wont to exaggerate practical difficulties, while taking a too narrow view of theoretical principles. Thus the *Railway Age* (May 14) sarcastically calls the railway bill recently passed

passed in Florida "the law to discourage railway investment in the State of Florida"; and, in speaking of Prof. Abbott's thesis, it says: "It is hardly probable that the address convinced a single railroad commissioner that his powers and emoluments ought to be dispensed with, and that the supervision of the railways ought to be turned over to a national board." As a matter of fact, though the address was courteously listened to, and ordered to be printed in the proceedings, any endorsement of Prof. Abbott's views was expressly disclaimed by the convention. The paper, however, may be profitably studied by all who wish to be thoroughly informed upon the history of court decisions, relating to governmental powers over commerce, upon existing incongruities, and upon the difficulties arising from independent regulation by States."

Competitions in Architectural Designing.

A NUMBER of the most reputable architects in New York have initiated a movement that should have been started at an earlier date, since the evils it is designed to correct have long been felt as a burden and have been many times pressed upon the attention of the profession and of the public. The movement is in the nature of a mutual agreement, which, already signed by a considerable number of leading architects, is, as we understand, to remain open for the signatures of all practising architects who favor its provisions. The agreement has for its object the stipulation of conditions under which reputable architects will compete with each other, and supply designs for such competitions. It is evidently hoped that this movement will tend to the diminution of the number of invitations to compete under conditions with which architects of good standing cannot comply. The stipulations in this agreement, to which the signers pledge themselves to adhere, provide for reimbursement of the cash outlay in preparing drawings for competition; for the naming of a definite number of competitors, not to be increased or diminished except by consent of the competing architects; for the payment of the standard fees for professional services (established by the American Institute of Architects) to the successful competitor; for the services of a professional adviser in arranging the programme of competition; for a general consultation, with those invited to compete, upon the subject of the programme; for the exclusion of all competitors who do not comply in all particulars with the requirements of the programme; that no additional drawings shall be demanded, or any new competition shall be instituted; and that the designs submitted shall be signed and, if desired, explained, by their authors. We have not thought it necessary to quote the precise language of the agreement in which these stipulations are couched; those desiring the full text may find it in the files of any of the American Architectural publications (*Architecture and Building*, Vol. XXVI., No. 20, contains it). Undoubtedly it is a movement in the right direction, well calculated to reform existing methods and to promote fairness in the conduct of competitions.

State Roads of Massachusetts.

MASSACHUSETTS, by legislation establishing a permanent highway commission, and by an appropriation of $300,000 for the construction of new roads and the reconstruction of old roads, has, as pointed out by Mr. Albert A. Pope, in *The State's Duty* for May, set the pace for the general improvement of highways throughout the United States. He says: "As a natural result of the popular agitation and the monster petition which I had the honor to present to congress in 1893, the United States recognized the necessity of a move in this direction, and, under 'the agricultural bill,' made a special appropriation of $10,000 to meet the expense of a careful investigation into the condition of roads throughout the country, and for the publication of such information as would assist the people in bettering their highways. The department of agriculture has issued a number of bulletins, and it is gratifying to learn that more than a score of States have already passed new road laws, while nearly all the others are planning for the adoption of measures for the promotion of

this reform. Experience has shown that the course pursued by Massachusetts is the one which commends itself most strongly both to the people at large and to their legal representatives, the various State legislatures, and it is natural to suppose that, if all were familiar with the work here, the knowledge would be utilized to bring about similar legislation wherever the method of procedure is still unsettled." In June, 1892, a temporary commission was appointed by the legislature of Massachussetts for investigating the condition of the public roads, and to draft a bill for their improvement. A law suggested by this commission passed in June, 1893. An act passed in June, 1894, not only increased the powers of the State commission, but permitted selectmen of any town, or the mayor and aldermen of any city, as well as county commissioners, to petition the highway commission for taking roads as State highways. The highway commission was also empowered to use the appropriation ($300,000), without further legislation, in building State highways. The commission, in accordance with its increased powers, has expended the money pretty evenly in fifteen counties. The apportionment of the money was based upon the facts of each case as determined by personal and official observation on the spot. The policy of expending the appropriations upon small sections of roads widely distributed was adopted on account of its educational value, each section being "an object-lesson to those living nearby." The report of the Massachusetts highway commission (January, 1895) is recommended for consultation to those who are considering legislation. A large amount of general information is compressed into Mr. Pope's article. A significant fact is that, where it has been found expedient to widen roads for the accommodation of increased traffic, the town officials, on account of the obvious advantages to owners whose property meets the highways, have been able, for the most part, to obtain the necessary releases without cost. Mr. Pope says that "thirty-eight sections have been contracted for, and only eight of them are to have a width of eighteen feet of hardened surface, all others being fifteen feet wide. As the primary object is to get length of way, the commissioners are considering the advisability of building single-track roads in the thinly-settled districts. These would not be over nine feet wide, with here and there portions of double width as convenient passing points for carriages. A mile and a half of such roads can be built for less than the cost of a mile of fifteen feet wide, and the advantage in getting produce to market is not lessened, provided such construction is confined to localities where the average traffic is from six to eight vehicles per hour. There is need of legislation to regulate the care of, and responsibility for, sidewalks on State highways. These, being of purely local advantage, should be under the supervision of the town, the wheelways alone being constructed and kept in order by the State. The laboratory work on road-building stones, in Lawrence Scientific School at Harvard University, is commended. An important feature of this work is a series of maps showing the situation of deposits of stone suitable for road-making, thus enabling the commission to obtain its supplies from the nearest available locality.

The Crucible as a Metallurgical Implement.

THE different kinds of crucibles in use for metallurgical operations are not many, for the simple reason that many materials more refractory than the metals to be fused, and capable of being formed into pots for melting these metals, do not exist. Certain qualities of sand, clays, and graphite,—popularly called plumbago, or black-lead,—are practically the principal materials from which melting-pots are made. A brief account of the crucibles used for various purposes in the arts, with more extended remarks upon their manufacture and their care in use, are given by Mr. John A. Walker, in *The Iron Age* (May 20). For laboratory use the smaller crucibles of platinum, porcelain, Hessian sand, and plumbago are used, these being substantially the same, except in size, as those for more extensive industrial use. "Straight-out clay crucibles," Mr. Walker tells us, are still used in metallurgy; but,

"while English steel-makers still cling to the use of the one-heat clay crucible, the vast bulk of all the metals and alloys are fused in the modern graphite crucible." The Hessian sand crucible is also still used more or less by assayers. The manufacture of the graphite crucible is said to be confined to six countries,—to wit, France, Germany, England, Japan, China, and America. The reasons for the more extensive use of graphite crucibles, as compared with crucibles of other kinds, are their more ready conduction of heat, which reduces the time required for fusion of their contents, their greater durability, resulting from their greater refractoriness and their superior strength and elasticity. This comparison of qualities applies to all other kinds of crucibles, except those of platinum, whose cost, however, precludes their use except for laboratory purposes; and platinum is even less refractory than graphite. The strength and durability of platinum crucibles, could these qualities be secured in an otherwise practical material costing no more than, and at the same time as refractory as, graphite, would render such a material an ideal one for the purpose. Few are aware of the care required for the successful manufacture of graphite crucibles. It is with this as with many other seemingly simple industrial processes whose very simplicity exacts the exercise of judgment and skill to a greater degree than other more complicated operations wherein the inherent qualities of the materials do not play so important a part. Mr. Walker says that the successful maker of graphite crucibles "must make constant chemical analyses of his materials, and he cannot have too much knowledge of the broad lines practised by his customers. The fusion points of different materials are vastly dissimilar. This must be taken seriously into account. For instance, the crucible made for steel-melting is useless in a brass foundry. It is far more refractory, it is true, but, if the brass-melter employed a crucible intended for steel-melting, it would slowly wither away in his lower temperature, whereas it would behave beautifully in a furnace at a temperature of 1,000° F. higher." This would seem to imply that high temperature is not the only disintegrating force in the destruction of a crucible. Mr. Walker gives no explanation of this alleged fact, which, we venture to say, will be new to the majority of readers, and it would have been interesting to know more precisely what there is in a brass furnace that will destroy a crucible of a given composition more quickly than a steel furnace at a temperature 1,000° higher. It may be that the explanation is implied in a succeeding paragraph, which treats of the effect of fluxes upon the binding materials of crucibles, but this is not explicitly stated. Summing up the "causes of unreasonably short life in crucibles," these are brought under three categories,—to wit., the want of adaptation of crucibles to the particular service in which they are to be employed, rough usage (often unavoidable), and "corrosive fluxes." "The crucible maker does not know what the melter will use; the melter does not always know the destructive influence of his flux on the walls of his particular melting-pot." It seems, therefore, advisable, that a mutual understanding between the manufacturer of crucibles and his customers upon the matter of fluxes should be sought, since it is implied that by a variation in the binding materials this destructive action could often be resisted.

The Uses of Exhaust Steam.

EXHAUST steam can be utilized in various ways. Condensed and separated from oily matters, it becomes a comparatively pure material for the manufacture of artificial ice. The purest ice to be obtained in our city markets is made of water condensed from exhaust steam. Water so condensed and separated from oily matter is also the best obtainable for boiler feed. The use of surface-condensers not only effects an economy of fuel, but supplies pure water for steam boilers in situations where the water is of such quality as otherwise not to permit its use for generating steam. Another use for exhaust steam is for heating buildings. On this use, Mr. Willard Hatch (*Iron Age*, May 6) has made some instructive observations,

which will be of use to those contemplating such an application. He assumes a building of definite proportions, using a given amount of steam power, and then considers the value of the exhaust steam for the two purposes of producing an increase of power by the use of a condenser, and the simultaneous heating of buildings, both of which applications may be made together during a considerable part of the year, in climates wherein the artificial heating of buildings is required. What the author calls incident heat in buildings—*i. e.*, heat developed mechanically, that derived from the persons of workmen, and that derived from gas jets—is shown to be an important factor in warming factories and workshops.

Arc Lighting in America and Europe.

AN interesting comparison of lighting systems in Europe and America was made in a paper read by Mr. C. Wiler before the Chicago Electrical Association, on April 16, an abstract of which was presented in *The Electrical Engineer* (May 5). The author claims for America the honor of being the birthplace of series arc-lighting, and asserts that, while, up to date, this system has scarcely gained a foothold in Europe, its application has been brought to a high degree of perfection in the United States. At the time the Brush and the Thomson-Houston dynamos were first introduced, the system of series arc-lighting was also introduced in England, and some of the original installations of the system are still in operation. Few additions to these installations have been made, and Mr. Wiler regards the method as now nearly abandoned in England. "The desire to supply arc and incandescent light as well as motive power from one and the same generator, the once low efficiency of arc dynamos, the use of small high-speed units, the consequently inferior arrangement of the steam plant, and, last, but not least, the high pressure for interior lighting" are causes influencing European opinion against the system of series arc-lighting. The force of some of these objections has been lessened in the United States by increase in the size of power units, decrease of dynamo speed, and increase in commercial efficiency. "The commercial efficiency of a 60-light dynamo now reaches 82 to 83 per cent., and of a 100-light about 86 per cent. Since the speed has been decreased to about 800 revolutions per minute for 60-light dynamos, and to 500 to 600 revolutions per minute for 100-light dynamos, it has been made possible to escape that labyrinth of counter-shafts, belts, pulleys, clutches, and bearings which for many years was characteristic of an arc plant." The direct connection of the dynamo with the steam-engine is the logical outcome of this advance. All this has naturally led to the predominance of series arc-lighting in America; and, although "arc-lighting by constant potential circuits was developed much later than in Europe, it has come into extensive use here since 1891, especially in large cities, for private lighting." Mr. Wiler's paper includes an illustrated description of the combined arc and railway plants of Munich; a table of data relating to various public arc-lighting plants in Europe and America; and an account of some particulars of European practice as contrasted with American.

Swiss Chalets.

A REMARKABLE, as well as a very interesting, exhibit at the Geneva National Exposition held last year forms the subjec of a leading article by Jean Schopfer in *The Architectural Record* (April-June), which, by the use of half-tone illustrations and descriptive text, conveys as good an idea of the actual exhibit as could be attained by those who did not actually attend the Exposition and study for themselves this feature of it. The exhibit comprised what was called a Swiss village, but it was probably unlike anything now to be seen in any one Swiss village, because it represented "one of the most interesting, and certainly the most original, chapters in the history of Swiss art,—that of house-building in wood,—and it was important that visitors should have before their eyes a picture of the surroundings amid which former generations passed their lives, and should see what a thorough and charming

sense of art, what graceful and picturesque originality, had been displayed by Switzerland in that architecture which is peculiarly her own." The arrangement upon historical lines which the carrying out of this idea compelled formed a unique and instructive representation of Swiss châlet architecture. Each house, or châlet, exhibited "exists, or did at one time exist, in reality; each has its date, its place of origin, in fact, its identity, fully established." The faithfulness of the reproduction was carried into every detail, and the exhibit was not representative in name merely, but in fact. The examples presented comprised "every architectonic form of wooden house, from the humblest and most modest, such as the little châlets (*mazots*) built high up on mountains to shelter the cowherds in the summer time, to the richest and most artistic creations in the way of carved and painted façades adorning châlets of the valley and of the plain, handsome inns, or dwellings of well-to-do farmers." In this successful attempt to reproduce a national feature, Mr. Schopfer sees "the revival of a style, and the restoration to a place of honor of a mode of house-building which can be employed at the present day, thus resuscitating a variety of most agreeable architectonic forms." These forms originated in the art of wood-working; carpentry, not the art of the stone-mason or the brick-builder, is the fountain from which they sprung. Mr. Schopfer criticises severely the wooden colonnades, frontons, attics, and porticos, so frequently found in American wooden buildings, and denounces this perversion as being "nothing less than an architectural heresy," and as a complete jumble of the most elementary principles of the building art, comparing it in this respect with an attempt "to reconstruct the Parthenon in iron." A contrast between the interior finish of Swiss châlets (wherein the beautiful natural effects of the wood are sought as much as possible) and the painted interiors of so many American houses is made, very much to the disadvantage of the latter. "In Switzerland, where the wood-working art has flourished and created a style, instead of masking and hiding the material employed, every effort has been exerted to make the most of its decorative properties; hence the joists are exposed, the projections of the upper floors emphasized, and the joints left uncovered; the roofs are developed, and the eaves extended, protecting the house and producing the finest decorative effect imaginable with their supporting brackets. Inside, wood forms are the basis of the ornamentation; the walls are wainscoted, and the beams left visible in the ceiling. This is the natural and logical decoration of the châlet. Following in this way the most simple and the most evident principles, a style of architecture has been created which is full of grace and originality." The disappointment the reader would otherwise feel because more of this interior work has not been made the subject of illustration is avoided by the promise made near the conclusion of the article that such a presentation will be made in a future number.

The Advantages of Down-Draft.

THE natural course for heated gases surrounded by a cooler medium is upward. It has probably occurred to many readers that, as carbonic acid and water are the principal products of the combustion of fuel, and as both carbonic acid and water at ordinary temperatures are heavier than air, if these products could have their heat usefully extracted till their temperatures were reduced to that of the atmosphere, they would, instead of rising, flow downward. Could this be realized in practice, we should have a natural down-draft. The modern down-drafts in furnaces are artificially produced. In a paper read before the St. Louis Association No. 2 of the National Association of Steam Engineers (April 27) and reported in *Sanitary Plumbing* (May 1), Mr. A. B. Hazard makes strong claims for the advantages of down-draft, in the application of which the green coal is placed upon the top of the fire, and the air is forced downward through the grate. He claims that in this system there is (*a*) complete combustion of gas; (*b*) a complete combustion of the fuel; (*c*) no deposit of soot

or tar; (*d*) a positive and rapid circulation of water in the water-tube grates, which, with down-draft are in the hottest part of the fire; (*e*) no cooling of the hot furnace and boiler by throwing open the doors of the combustion chamber, as in the up-draft systems; (*f*) much greater durability of grates; (*g*) increase of steaming capacity over that of boilers of the same size fired in the ordinary way; and (*h*) perfect smoke consumption. Of course, if these claims are sustained in practice, the logical result, increased efficiency, must inevitably follow. This is claimed to be from "ten to fifty per cent., depending on the kind of boiler, and upon other conditions." We do not desire to be understood as endorsing the claims made by Mr. Hazard, but we present them, in substance, for what they are worth as indicating merit in the down-draft system.

The Michigan College of Mines.

THE name of the institution formerly known as the "Michigan School of Mines" has, under an act of the legislature, been changed to the "Michigan College of Mines." Further legislation has fixed the rate of tuition in favor of the residents of the State. The rate for non-residents within certain limits is left to the determination of the board of control of the college. This latter rate has not yet been fully decided, but we are informed that it is likely to be $150, while for residents it will be only $25. The probable charge for non-residents will correspond with tuition fees in other first-class American technical schools. A letter from secretary F. H. Scott, says that, "when the school was working out its policy, and trying to solve its educational problems, it was thought wisest to charge no tuition, but to collect as wide a constituency as possible, in order that there might be all possible chance to make the methods as broad and thorough as could be done. It was also deemed hardly just to the students educated here to demand tuition until the institution was much better equipped for its work than the appropriations granted during the first decade of its existence permitted. Now that success has been attained in educating men for practical work, as is evidenced by the positions which its eighty-six graduates hold,—a list of which is given in the last catalogue,—the institution seems fully warranted in charging hereafter for its instruction. The new law goes into effect immediately after August 19, 1897, and will therefore not apply to students entering previous to that time. A prospectus will soon be issued by the college, giving the details of the regulations finally adopted by the board of control.

Glowing of Disconnected Incandescent Lamps.

IN March, 1893, Mr. N. S. Amstutz published an account of observations upon the glowing of disconnected incandescent lamps excited by friction of the hand upon the bulbs. The observations were made in September, 1892. The original announcement was made in *Electricity* (March, 1893), and in the same paper (May 12, 1897) the same author presents an account of an investigation of light that can be produced in this way. Instead of friction generated by the hand, he employed in this investigation (March 27, 1897) a tube of transparent celluloid, into which the bulb of the lamp was introduced and rotated to generate the required friction. The base of the lamp was attached to a short shaft or spindle, upon which a small belt-driven pulley was fastened. The results obtained confirm, he asserts, the estimates made in 1892 upon the amount of power required to generate a unit of illumination, which was then determined to be about 45 per cent. of that required in ordinary practice. The quantity of illumination thus obtained with a single lamp is, however, small. The facts presented in the article enable an experimenter to demonstrate with very simple apparatus a number of the phenomena connected with vacuum tubes. An illustration of the apparatus is also given.

THE BRITISH PRESS

Railway Communication With India.

IT certainly seems wonderful, when the closeness of the long-standing ties which bind the East Indian colonies to the mother country are considered, and when, at the same time, the extension of railway communication during the last quarter of a century is regarded, that persistent efforts for facilitating railway transit between these lands have not been made. On the contrary, in a paper by Mr. C. E. D. Black, published in the *Journal of the Society of Arts* (May 7), he states that "practically nothing has been done to carry out the idea . . . Between the two countries there is a never-ceasing stream of officials, soldiers, sailors, merchants, and miscellaneous travellers, to say nothing of wives, children, and servants, which, though it flows more copiously during the cold season, never dries up, and is a striking criterion of the enormous bulk and the supreme importance of the commercial and administrative intercourse between the Indian empire and Great Britain." Mr. Black says, no doubt with truth, that the government of this empire of 270,000,000 inhabitants from a base six thousand miles away is not rivalled in the entire world, and it might well be added that it has no precedent in the history of the world. His proposition that it is of the highest importance "to shorten communications between the two countries . . . especially in the case of war, mutiny, or any great or sudden emergency," seems self-evident, but an inquiry into the possibilities of the case shows that routes geographically the most desirable are, for political reasons, not available. "As Europe, Asia, and Africa lie across our direct road to the east, it behooves us to consider carefully how to select the route which shall be, as far as possible, secure from molestation or interruption at the hands of others, and which shall lie within our own sphere of influence and control. I am afraid this important condition at once rules out the idea of a grand trunk line which shall begin at Calais, and, passing through Constantinople and Asia Minor, emerge at Candahar or Peshawar. Not that I mean to deny the possibility or the advantage of such a line; for improved railways mean enlarged intercourse and the strengthening of peaceful bonds between nations. But no such trunk line, traversing the actual arena of international jealousies and complications, and passing through the very focus of the eastern question, will fulfil the idea of a British imperial line designed to bridge over the physical gulf between Great Britain and her possessions in the East. Fortunately, so long as we have posssession of the Mediterranean, the necessity for quicker transit over the western or European half of the route to the east is not felt so much. It is difficult to conceive of any possible political combination which would deprive us, all at once, of Marseilles, Brindisi, and Salonica entrepots in time of peace, or of the Mediterranean itself in time of war. The Cape route is, of course, available in the last resort, but I assume that we shall always cleave to the Mediterranean route, come what may, and our tenure of Gibraltar, Malta, Cyprus, and Cairo, are, I take it, very substantial and solid guarantees of this national determination. It is when we reach Egypt, the half-way house, that the question suggests itself, now that we have emerged from the nervous and energetic sphere of busy European rivalry into the calmer atmosphere of oriental repose: Cannot we choose a shorter cut than the long round-about Red sea and Indian ocean route? Look at the map, and you will see what a huge obstruction is presented by the enormous peninsula of Arabia, which juts out southward for over two thousand miles, causing a wearisome detour of from two to three days down the Red sea, while the further transit across the Arabian sea to India is of equal, and sometimes longer, duration. A straight line drawn as the crow flies, from the northern end of the Suez canal to Kurrachee, or whatever we may fix upon

as the western land gate of India, coincides with the route which, I venture to say, is the shortest and best line for a railway to India." Mr. Black admits that he hazards something in so strongly recommending a line yet unexplored either by himself or others; but, as various sections of it have been traversed without discovery of any important obstacles to railway construction, and as he has, in the geographical department of the India office improved the excellent opportunities there afforded of studying the geography of the region the proposed road would traverse, he feels justified in his belief in the route. At any rate he thinks that it presents attractions sufficient to warrant its exhaustive investigation before the consideration of any other scheme.

Is the Pacific Cable a Practicable Scheme?

WITH reference to the supposed difficulties to be surmounted in the laying of this proposed cable, *The Electrical Review* (London, April 30), criticising an article which recently appeared in the *Electrical Engineer* (New York), says that business men, both in Canada and England, have been convinced for many years that such a cable would have a sufficient earning capacity, but that "the interests of a powerful combination of telegraph companies controlling the network of cable and land-lines now serving the needs of, practically, the whole civilized world have been made the most of to create doubts, now happily dispelled." Exception is taken to the views of our New York contemporary with reference to the difficulties of the scheme, regarded from an engineering stand-point. Of these the most prominent arise from what the *Electrical Engineer* styles "the extreme lengths between landing places," and "the enormous depths." In its discussion of these points, it is charged that the language used is such as to lead "the casual reader to infer that 7,000 miles is the length of one section, instead of being somewhere about the length of the entire system." It is then claimed that, as the longest section of the cable would really be about 3,500 nautical miles, a working-speed of fifteen or eighteen words per minute could be easily attained over this section. A further criticism is made upon the use of statute miles in expressing depths, nautical miles, or fathoms, being preferable in comparisons of the Atlantic and Pacific for cable purposes. On this point *The Electrical Review* says: "The former runs the latter pretty closely in the matter of depths. Between Bermuda and Porto Rico, for example, on a line of soundings, there are depths of from 2,875 fathoms near Bermuda to 3,875 fathoms near to Porto Rico. The deepest sounding in the Atlantic yet discovered is in close proximity to this latter island, where the depth encountered is 4,561 fathoms, and not 4,620 fathoms, as our contemporary believes. Another line of soundings from Porto Rico towards Charleston, U. S., shows depths of from 2,990 fathoms to 3,133 fathoms. There are soundings between Africa and the West Indies of 2,500 fathoms to over 3,000 fathoms. Yet this would not deter the Spanish government from laying a cable to Cuba, if they possessed the funds necessary. In the South Atlantic, between Ascension Island and the River Plate, is a line of soundings with over 3,000 fathoms at the deepest part." It is then shown that, while soundings of from 5,022 fathoms to 5,155 fathoms have been made in the Pacific, the extreme depths lie outside the track of a cable. Thus, between New Zealand and Fiji the average of many soundings is 2,500 fathoms; between California and the Sandwich Islands the deepest of abundant soundings is 3,000 fathoms; between Vancouver and the Sandwich Islands, 3,115 fathoms is named as the greatest depth. It is admitted that between the Sandwich group and Japan there are soundings of from 4,000 to 4,643 fathoms, but it is claimed that these are in deep gorges that may and would be avoided in laying cables. It is held that other exceptionally great depths in the Pacific are in so isolated positions as not to interfere with cable-laying. It is also claimed that the problem of successfully laying a Pacific cable has already been "solved in theory by practical engineers on both sides of the Atlantic"; that

"the deepest Atlantic cable lies in 2,850 fathoms"; "that no great difficulty was experienced in laying it," and that the idea that volcanic action, in its disturbance of the sea bottom, is more to be dreaded in the Pacific than in the Atlantic Ocean is not sustained by facts. A further criticism is made with reference to the temperatures of the two oceans, the differences in which (it is asserted in opposition to the statement that deep water is colder in the Pacific than in the Atlantic) "are not appreciable at depths greater than 3,000 fathoms. Exception is also taken to the speculative belief that the increase of pressure at great depths would adversely influence a well-constructed, light, armored type of deep sea cable: and it is calculated that the maximum pressure to which such a cable would be subjected on any possible route for a Pacific cable would be 3.9 tons per square inch.

Fire-clay Building Materials.

THE large and increasing employment of fire-clay manufacturers in building justified the presentation of a paper upon these products, read by Mr. W. H. Allen before the Northern Architectural Association (Eng.), and reported in *The Architect & Contract Reporter* (April 30). The paper relates principally to the manufacture of sanitary pipes and specialties, glazed bricks, scullery sinks, white channel bands, closets, etc. Of course the quality of the articles manufactured depends, first, upon the quality of the material, and, secondly, upon the knowledge and skill applied to the manufacture. In order that architects and builders may be able to judge wisely of the quality of fire-clay goods, they ought to possess a general knowledge of the material, of the sources whence good qualities of fire-clay can be obtained, and of the methods whereby the plastic material is converted into a hard, strong, impervious mass, shaped into desired forms. In England fire-clays are found in abundance in the coal measures of Northumberland and Durham, most frequently as the floor or under-stratum of seams of coal, and in layers from one to six feet thick. It has a slate grey color, and the better qualities, free from impurities, have a greasy feel. Fire-clays are chiefly composed of silica and alumina in varying proportions, a fair average for the English clays being fifty to fifty-five per cent. of silica, and thirty to twenty-seven per cent. of alumina. Of course, the greater part of the fire-clay output is used for heat-resisting purposes, but this, being aside from the author's purpose, is passed with only brief mention. In Corbridge, Eng., a special kind of fire-clay, of very fine quality, is obtained. It lies apart from the coal measures, has a reddish brown tint, and, when burned, acquires a very dense body, similar to that of stoneware. The first step in the preparation of fire-clay for manufacture is the grinding into powder of the required fineness (according to the articles intended to be made) of the large, hard lumps as they come from the pit.

For heat-resisting purposes the clay is coarsely ground; for salt-glazed goods finer grinding is needed; and for white goods the finest grinding of all is required. For the latter purpose, also, great care is exerted to procure clay free from nodules of ironstone. The latter, when present, fuse in the kiln, and ruin the product, The grinding is effected by the use of a revolving pan, within which are two metal rollers. From the grinding mills the ground clay is carried by elevators to a revolving riddle, by which it is separated into parts of the required different degrees of fineness. Mr. Allen says that this treatment has largely superseded older methods, though the latter are still more or less retained. The general steps of the manufacture are the moulding and burning, the first being largely performed by moulding machines, and the latter in kilns adapted to the kind of articles manufactured. Moulding gives the required form, and burning the required solidity, strength, and rigidity. Salt glazing is done when the kiln is at its hottest stage of firing. It is extremely simple to do, but the chemical reaction which forms the glaze is not quite so simple, although easily enough understood by chemists. When the right period arrives, and the

heat has risen to a point sufficient to volatilize common salt in, say, a kiln for burning sanitary pipe, several barrowsful of the salt are thrown into the kiln. This salt, vaporized by the heat, permeates every part of the kiln, and, aided by the watery vapor, also present in the kiln a chemical reaction between the salt vapor and the silica of the clay articles takes place, the result being the permanent vitrous surface or glaze with which every one is familiar. Glazed bricks are surfaced in a different way. They are first burned to only a moderate degree of hardness, then taken from the kiln, dipped in a liquid glazing material, and then reburned. Few have a clear idea of the amount of labor needed to manufacture glazed bricks. Each brick has to be handled twenty times. The conduct of the various processes to a successful issue require the exercise of great judgment and care, and sometimes great loss is incurred by failure, as in the improper mixing of the body and glaze. This requires the utmost exactness; a very slight error in weighing may cause the bricks either to craze, or not to glaze properly, according as the error is one of excess or deficiency. The manufacture is, therefore, notably one which entails serious risks. There are two systems employed in the manufacture of white goods, such as scullery sinks, etc. In some cases twice firing and glazing, as with glazed bricks, is practiced; in others the body and glazing material are applied with a brush, and a single burning suffices. The choice of methods depends upon local conditions. On the whole, the entire line of fire-clay goods used in building probably exacts from manufacturers a greater degree of care, and entails more risk, than any other class of materials used in modern building construction.

Gravity Stamp-Mill Practice.

THE first part of a paper comprising an account of an important study of the mechanics of gravity stamp mills is printed in *Industries and Iron* (May 7). The author is Mr. D. B. Morison, who read the paper at a meeting of the North-East Coast Institution of Engineers and Shipbuilders at Newcastle-upon-Tyne (April 30). The study has a direct practical application to the increased efficiency and durability of gravity stamp mills, to which appliance (improved principally by American engineers) the change in the status of gold mining from a purely speculative to a thoroughly-organized, standard, and permanent industry is largely due. Though hardly needed for his purpose, the author introduces the subject with a general statement of the function of the gravitation stamp mill, and an account of the crude forms used in the Hartz mines, Germany, and the Cornish mines from which the modern stamp mill has been evolved. The general construction of a gravitation stamp mill is illustrated by engravings, and an analysis of the action of this class of mills, and the physical law that would control the fall of the stamps in the absence of friction,—*vis inertia* and the resistance of the material to be crushed,—is made. But, as it is obvious that the conditions named materially modify the action of the law of gravity in stamp-mill practice, the extent of this modification becomes a proper subject for experimental investigation, and the account of such a research is embodied in Mr. Morison's paper. This part of the paper—illustrated by diagrams—shows very clearly the shocks, strains, and vibrations to which stamp mills may be, and too frequently are, needlessly subjected. The stamp, if an attempt be made to make it drop too often, may in its fall meet the lifting cam, the latter rotating too fast to synchronize with the fall of the stamp. The stamp, if lifted too quickly, will, by its *vis inertia*, move higher than the cam is intended to lift it. It takes time for the stamp to pass upward and return through this superfluous distance. The friction is also a retarding force of varying magnitude, not only in different mills, but in the same machine. These elements unite in imposing limitations of speed upon the operation of stamp-mills, and as the theoretical time in which the stamps drop through a given distance is less than the actual time required in practice, there is no way of determining the practical time limit by

calculation. Only the experimental method remains. The method of carrying out these experiments, the graphic method of expressing results, and the data required are embodied in the paper. It was, for example, ascertained that "a cam stamp having a seven-inch drop cannot be driven at more than from ninety-four to ninety-eight drops per minute" in ordinary work, and that the combined effect of the elements of resistance reduced the efficiency of the drop by seventeen per cent., as compared with that of the same weight falling freely *in vacuo*. In practical work a reduction of efficiency of from twenty to twenty-five per cent. is a probable average. Since gold mining has now come to rank with other permanent industries in the matter of profits made by rigid enforcement of economies, the loss of efficiency in stamp-mill practice is not insignificant, nor will it be anywhere considered a negligible factor in the cost of getting gold.

Carbureted Water Gas as an Enricher of Coal Gas.

IT is well known that serious objection has been made to the use of carbureted water gas as an illuminant in dwellings on account of the proportion of carbon monoxid it contains as compared with coal gas. The water gas escaping into a room from a leak or from an imperfectly-closed gas tap is, on this account, considered more dangerous to life than coal gas. Carbureted water gas sometimes contains as much as twenty-eight per cent. of carbon monoxid, while coal gas does not usually contain more than six or seven per cent. But, while the use of carbureted water gas by itself may be thus more dangerous than the use of coal gas, it is possible and practicable to use water gas as an enricher of coal gas without much enhancing the risks to life and health through accidental leakages, and without material reduction of lighting and heating values. A summary (*The Gas World*, April 17) of a recent report made by Professor Lewes to the Birkenhead gas committee will allay some apprehensions that have existed relative to the use of water gas as an enricher. Professor Lewes concludes that there is no danger in sending out a mixture of coal gas and carbureted water gas, provided the mixture does not contain more than seventeen per cent. of carbon monoxid, and that such a mixture is, for all practical purposes, as good as coal gas, and superior to coal gas for incandescent lighting. The data and reasons upon which these conclusions are based are given. In examinations of coal and cannel gas, he found an average of 5.99 per cent. of carbon monoxid. In carbureted water gas he found an average of 29.03 per cent., the highest percentage having been 29.78. In the coal gas enriched by the carbureted water gas, as sent out, he found the mean percentage of carbon monoxid to be 14.49, the highest percentage being 14.50,—2.50 per cent. less than the maximum percentage of carbon monoxid above stated as permissible. In answering the question as to what percentage of carbureted water gas can with safety be mixed in a town supply of coal gas, Professor Lewes avows his appreciation of the grave responsibility, and states that he would decline to answer, were it not that in his position as superintending gas-examiner to the corporation of the city of London, he has been obliged to consider very carefully to what extent carbureted water gas can be allowed to replace coal gas without danger to the consumers. He alludes to the fact that carbon monoxid is the most dangerous gaseous poison there is, and he condemns the attempt made by some supporters of water gas to conceal this fact. He believes that the only proper way to meet this question is to concede the dangerous properties of the gas, and to so arrange the percentage of it, when used for enrichment, that only under abnormal and accidental conditions, impossible of prevention, need the risk of its use be dreaded. "The breaking of a gas main near the basement of a house and infiltration of large volumes of gas into the house itself, the fall of a chandelier, or a serious leakage from it when pulled too low, and the accidental cutting into a supply-pipe in a wall, would all give leak-

age of a sufficiently serious character to form a poisonous mixture, fatal, in time, to life, whether the escaping gas were coal or carbureted water gas, and this class of accident must be put aside. The smell of carbureted water gas being even more penetrating than that of coal gas, a leakage becomes perceptible to the nose when the air contains one ten-thousandth part of the gas, which proportion would be absolutely without action on health." From this it follows that only during sleep could a leakage of carbureted water gas become dangerous to life. "The usual chances of leaks are from such unlikely circumstances as the gas being blown out,—an extremely difficult thing to do,—or being extinguished by collection of water in the supply-pipes, or by an irregularity in the working of the meter"; and Professor Lewes asserts that, in a fairly long experience of coal-gas consumption, no such instances have come to his knowledge. He does not on that account deny their possibility. Both carbureted water gas and coal gas have practically the same illuminating value; the same fittings and burners answer for both. The mixture of coal gas with carbureted water gas gives off about two and three-fourths per cent. less heat than coal gas when used in stoves, cookers, and engines,—a percentage quite immaterial. The products of combustion of such mixtures are no more unfavorable to health than the products of combustion of coal gas alone. Carbureted water gas is freer from sulphur compounds than coal and cannel gas, and therefore its products of combustion are less injurious to books, gilding, etc., in apartments than are the products of combustion of coal gas. The enriched coal gas is more suitable for incandescent mantle burners, because it deposits less carbon on the mantles, and thus less light is lost.

The Mussy Viaduct.

THIS specimen of engineering is about the only feature of more than ordinary interest on the recently-completed railway from Paray-le-Monial to Lozanne and Givors in central France. It was designed by MM. Geoffroy, Moris, and Ponthier, engineers of the Paris, Lyons & Mediterranean Railway Company, and the design was carried out by MM. Vaysserye. From an illustrated description of this viaduct in *Engineering* (April 30) the following abstract, setting forth interesting features of the construction, has been prepared. The total length of the structure is about 1,800 feet, and it is built wholly of masonry. Five of the nineteen piers have a height of 197 feet from the ground to rail-level. "The lower parts of the piers form pedestals, in the highest piers at a height of 42 feet; at this level there is a set-off of 12 inches, from which the shaft of the pier rises, interrupted at intervals by courses of cut stone." The contractor's plant for carrying out the work comprised five miles of railway, exclusive of an extensive system of branch narrow-gage railways, the latter leading from the central power station, where the cement and mortar were prepared, and the former extending to the quarry from which the stone was obtained. It having been impracticable to obtain sand for admixture in the mortar and cement, pulverized granite was substituted. A special plant for the supply of this material was thus necessitated, consisting of crushing, grinding, screening, and washing appliances. "Water was obtained, from an adjoining canal situated at a higher level than the stream in the Mussy valley, and turned into a large basin, in which the screened granite was deposited; from this basin it was discharged through a sloping channel, in a stream having considerable velocity, into a second basin some forty yards distant, where the pulverized granite was allowed to settle, the water being run off into the Mussy." Three of these washing arrangements were employed. No difficulty was experienced in erecting the pedestals of the piers. The method of erecting the tall shafts of the piers above the pedestals was adopted with a view to cheapness as well as efficiency. It dispensed with scaffolding, which would certainly have cost much because of the height of the piers, and was found to be wholly satisfactory in its application. It is described as follows: "To meet this difficulty . . . MM. Taysseyre con-

structed a sufficient number of light, easily-erected or removed girders of such a length that they could take their bearings on the completed bases of the piers. The ends of these girders were fitted with lifting screws, and they served as convenient platforms from which to hoist material and to proceed with the erection of the piers for a suitable distance. As soon as the convenient limit was reached, the girders were raised by the lifting screws and the erection of the piers proceeded with. In this manner all the piers were completed without the aid of scaffolding. Only a limited number of these platforms were constructed, in order to save expense, so that the work of completing all the piers was not carried on simultaneously, but, as soon as two piers were completed, the platform was lowered, taken apart, and re-erected on another part of the viaduct." These platforms were 88 feet long and constructed for a safe load of six tons in the middle. On their floors were laid two lines of narrow-gage railway, with crossings and turn tables for the trolleys. The piers were connected at the springing level by five steel cables, at intervals of 65 inches, attached to cramps let into the masonry. Planking was laid on these cables, which were tested to a central load of two tons. "The timber was raised by tackle operated from a fixed hoist. As soon as the centring was completed, a temporary gangway about ten feet wide was erected on it for the whole length of the viaduct, and two tracks of 20-inch gage were laid down to allow of the transport of material to any desired point." The stone was hoisted from the bottom up the slope of the valley on an inclined plane, by a steam winch which hauled the stone-laden trolleys up the plane and on to the temporary gangway, the empty trucks returning by gravity. It is evident that the methods employed in the construction of this bridge are an example of engineering that can be profitably studied, and that will probably be followed in the erection of future viaducts requiring piers of unusual height. The data of cost are not presented in the article reviewed.

Electrical Action of Carbon in Flames.

IT IS a fact that, notwithstanding all that has been accomplished in the field of electrical discovery, the attitude of the public mind toward electric research is that of confident expectation. This attitude is maintained by the frequent announcement of discoveries—results of experimental investigations—which, while not in themselves revolutionary, or, so far as present indications go, even calculated to initiate any important change in current practice, are yet of a character to show how narrow is the margin of the field already cultivated, and how broad and rich is that portion yet untilled. Among recent discoveries which seem to disclose vistas of future possibilities may be classed the results of experiments communicated to *The Electrical Review* (May 7) by Richard P. Fuge. These results indicate that a battery producing a small current of high electromotive force can be constructed, in which the positive plate may be of carbon, or in which carbon in different allotropic conditions may be used for both positive and negative plates. If platinum electrodes are inserted in a flame and connected by a conductor, a current passing through the conducting wire indicates that different parts of the flame have different degrees of electromotive force. By adjusting the electrodes in the flame, the portions of the latter possessing the same electromotive force can be determined. The experiment can be varied by using two electrodes of different metals (*e.g.*, zinc and copper), both placed in a part of the flame having a uniform electromotive force. In such a case a current will pass through the conductor corresponding with the difference of electromotive force in the two metals. Now Mr. Fuge has gone still further in this line of experiment by employing electrodes of carbon instead of metal, using high insulation, taking care to place the electrodes in flame at the same potential, and measuring the results by a high-resistance Kelvin reflecting galvanometer, and a condenser of one microfarad capacity for comparing the electromotive force generated with a standard Daniell cell. In this way he has been

able, he asserts, to sometimes produce an electromotive force higher than 1.7 volts between a positive plate of wood charcoal and a negative of plumbago. Analogous results were obtained with retort carbon used as a negative electrode. For other interesting phases of this series of experiments, the reader is advised to consult the original paper. With reference to a successful repetition of experiments of this kind Mr. Fuge says: "The wood-charcoal used must be thoroughly carbonized; otherwise its resistance may be so high that no result will be obtained; the charcoal that was used with the best results is that sold as 'blow-pipe charcoal.' In most cases its resistance was measured beforehand. . . . The retort charcoal was, in all cases, the ordinary rod-carbon used in arc lights." Of course it is quite useless to speculate about what may be the practical outcome of this discovery, which throws additional light upon the problem of the generation of electricity directly from carbon.

Automatic Extinction of Lamps.

AN ingenious arrangement of street-lighting, which allows a reduction of the illumination at any time when less light is needed, is described in the *Electrical Review* (March 26). This arrangement is now in use in several places, but Portsmouth, England, is considered a notable instance, as the system has been successful there. It appears to be a system of automatic switches. "The automatic switch, which is being used on 240 lamp-posts, is designed so that, when the arc lamps are turned off, the incandescent lamps are automatically lighted." It ought to be explained that each lamp pillar has an arc lamp as well as two incandescent lamps, the latter being employed during the period when the lesser illumination is desired. "The device consists of a coil in series with the arc light, and, when the arc lights are burning, the coil becomes energized and attracts the end of a lever; when, however, the arc lamps are extinguished, the rocking arm drops down upon a knife-edged switch, and this action has the effect of completing the incandescent circuit, thereby turning on the glow lamps." The paper quoted illustrates this arrangement by engravings which cannot here be reproduced.

The operation, however, is so simple that its general features may be understood without engravings. When the lever spoken of drops, the incandescent circuit is completed, the current passing through a tube straight to the lamps, returning to the switch through the arm of the lever and out again. This provides for the lighting of the glow lamps at the instant of extinguishing the arc light. The extinguishing of the incandescent lamps, in their turn, is accomplished by sending a reverse current through the arc lamps and consequently through the coil, thus lifting the lever out of the switch and cutting out the incandescent lamps. To prevent the lever from falling back again into the switch, a permanent magnet is pivoted under the solenoid in such a manner that it may move horizontally. This magnet carries a catch, which, passing under the arm of the lever, holds it from falling back on to the switch when the current through the series coil is interrupted, while, at the same time, it permits the core of the solenoid to drop down to its original position. To insure that the lamps are all effectually cut out, the reverse current is turned on for about five minutes. When the current for the arc lights is sent through the lamps, the pivoted magnet which operates the catch is drawn back into its original position, which leaves the lever free to act, according as the coil is magnetized or demagnetized. The use of this apparatus in Portsmouth is estimated to have saved the wages of three men.

THE FRENCH AND GERMAN PRESS

The Supporting Power of Soils.

WE have already noticed in these pages the apparatus devised by the city engineer of Vienna, Herr Rudolf Mayer, for measuring the supporting power of soils. Herr Mayer now contributes to the *Oesterr. Monatschr. für den oeffent. Baudienst* for March a fuller account of his experiments, with scale drawings not only of his precise apparatus, but also of a less delicate and more practical device for general use by builders and by superintendents of building operations. The basis upon which such tests should be made is that of the rate of yielding to pressure. Up to a certain limit the depth to which a given loaded area sinks is directly proportional to the load which it bears, and this limit should in no case be exceeded. Herr Mayer's simple apparatus is intended to determine this limit with a degree of precision amply sufficient to enable the builder to proceed intelligently. As already described, the original apparatus consisted of a base plate and cylinder into which a plunger is fitted, and upon which weight can be placed corresponding successively to uniform pressures per unit of area. The corresponding sinking of the plunger into the soil is then very precisely measured by a micrometer upon a multiplying column, arranged with differential cylinders, and the results of systematic increases of pressure are plotted in a curve.

For practical use this apparatus is replaced by a rod carrying a divided head, upon which a tube containing a spiral spring is fitted. The end of the rod is provided with a number of tips of various determined areas, in order that one adapted to the nature of the soil may be selected; and, by pressing this upon various portions of the ground to be tested, and taking the readings from the spring scale, the relation between the pressure and the penetration may be obtained.

The entire subject is one upon which there is very little experimental information on record, and, while still further improvements may be made in the appliances for its investigation, Herr Mayer is to be congratulated upon bringing the matter to professional notice.

The Heilmann Electric Locomotive.

THE experiments made several years ago with the Heilmann electric locomotive by the Western Railway of France was sufficiently satisfactory to induce the management to undertake the construction of a larger engine, embodying the results of the experience thus gained, and the accounts of the performance of the new engine are given, with a full description and illustrations, in *Glaser's Annalen* for April 15.

The Heilmann locomotive is practically a travelling power-house, carrying its own boiler, engines, generators, and motors, and hence hardly realizes the popular idea of an electric locomotive as a sort of mammoth trolley car. The actual advantages expected from the Heilmann type of engine are to be gained in the elimination of all the reciprocating parts, the introduction of high-speed compound engines, the possibility of small wheels on swivel trucks, thus giving a flexible wheel base, yet making all the wheels drivers, and the possibility of controlling, regulating, and reversing the speed of the locomotive without altering the speed or direction of the engines.

In the locomotive now completed the steam is generated in an ordinary locomotive boiler, and supplies two Willans compound engines, each engine having three pairs of cylinders, cranks being set at 120 degrees apart. The cylinders have a stroke of 7.6 inches and 12.2 inches by 10.15 inches running at 400 revolutions, and the two engines indicate 1,350 h. p. At each end of the shaft is attached a generator of the continuous-current type, built by Brown, Boveri & Co., supplying a current of 1,000 amperes and 455 volts, the whole of this machinery being placed longitudinally in the center of the locomotive, aft of the boiler. There is also an

auxiliary engine and dynamo for lighting the train.

On each of the eight wheel shafts is mounted a motor of 125 h. p., the armature of the motor being carried on an annular shaft concentric with the axle, and the speed being reduced by internal gearing. The total length of the locomotive is about 60 feet, and the weight 115 tons, and a speed of about 60 miles an hour has been attained.

While it seems a mistake to attempt the construction of a high-speed power house when so much of the plant might have been permitted to remain stationary, there is no doubt that many advantages will be gained by the removal of the reciprocating parts; and the experience gained with the Heilmann locomotive will do much towards convincing railroad men of the capacity of electric motors for heavy service. The Heilmann locomotive can run over any of the existing tracks without requiring the installation of any permament plant or line wire, and, when it is seen what can be done in this intermediate way, the introduction of stationary plants and general electric driving must follow. In the meantime the experience gained with this engine will be of much value, and its performance cannot fail to be watched with interest.

The Manchurian Railway

DOUBTLESS many reasons, of which the political significance will appear in due time, prompted the intervention of Russia between Japan and China in the recent war, and apparently one of those reasons has already shown itself in the proposed changes in the route of the Trans-Siberian Railway.

As originally planned, the railway, after crossing Lake Baikal, was to be carried through the Amoor province, following the valley of the Schilka and the Amoor, keeping entirely within Russian territory. The main line of the road is already completed to Krasnoiarsk, on the Yenesei, and construction is progressing to Lake Baikal, but explorations of the projected route along the Amoor valley have revealed the existence of dense forests, which make the (estimated) cost of construction more than $100,000 per mile; as this portion of the road would be more than 1,200 miles in length, the total is enough to cause hesitation and search for some less costly route.

The only alternative is to carry the road through Manchuria, thus passing into Chinese territory; two routes have already been surveyed, and plans made for the execution of the work.

As an offset to the objection of leaving Russian territory, numerous advantages will result from the change. The length of the road will be shortened by about 300 miles, the forests will be replaced by the plains of Manchuria, and the pass through the Chingan Mountains is much less difficult than that through the Yablonoi range, which the original plan included.

Negotiations with the Chinese government are said to have been satisfactorily concluded, and the entire road is to be completed within five years, thus giving Russia through communication by rail with the port of Vladivostock.

Full details of this portion of the road are given in the *Zeitschrift des Oesterr. Ing. und Arch. Vereines*, for March 19, with map.

The Development of the Gas Engine.

AT the recent expositions at Geneva and at Berlin there were no exhibits which displayed attention to points of development to a greater extent than did the group of internal combustion motors, including gas and petroleum engines; while no radically new engines were shown, the general line of improvement in proportions, performance, and general design was worthy of notice.

The exhibits at both expositions are fully reviewed in the issue of the *Zeitschrift des Vereines Deutscher Ingenieure* for April 10, with many illustrations, some of which are interesting.

The cost of coal gas has caused especial attention to be given to petroleum motors, and among these the portable engine of Altmann and the traction engine of Hartmann are of interest. In both of these engines the circulation of water about the

cylinder is replaced by a larger water jacket, in which no attempt at circulation is attempted, the water being allowed to reach the boiling-point and pass off as steam. Although this plan is adopted mainly because of the inconvenience of carrying water, in fact it occasions not only an economy of water, but also a higher efficiency of the engine, owing to the higher temperature of the cylinder walls. This is especially desirable in the case of petroleum motors, as the hot cylinder prevents the condensation of vapor on the walls, and adds to the certainty and effect of the explosion.

Among the gas engines, properly so-called, one of the best was a fine motor of 60 h. p., built by the Berlin Anhalt Machine Works. This engine, which was practically a well-designed motor using the Otto, or Beau de Rochas, cycle, developed on test 75.8 brake horse power with a consumption of 17.1 cubic feet of gas per horse power per hour, and gave the following high efficiency:

Heat converted into work...31.5 per cent.
" rejected in cooling water.20.7
" in exhaust and radiation.47.8

100.0

A novelty in the shape of a gas hammer was also shown, besides some very simple small motors, and it is evident that, with the advent of a suitable cheap fuel gas, of a character suited to be used in motors, the internal combustion engine will develop with such rapidity, both as to efficiency and capacity, as to crowd the more wasteful steam motor very hard for many purposes.

Petroleum as Fuel.

NOTWITHSTANDING the small use of petroleum as a fuel in the United States, its use on the Russian railways continues to increase, and that, too, without causing any alarming increase in the price of refuse. *La Revue Technique* (April 23) gives a review of the investigations of the Russian engineers, MM. Goulichambaroff and Arzich, upon the use of petroleum residues in locomotive-firing, showing that the advantages already made public in the papers of Mr. Urquhart and Sig. Soliani continue to be borne out in practice.

The method of burning the refuse is practically that which has been in use for a number of years, the liquid being pulverized by jets of superheated steam, concentric, flat, and annular pulverizers all being used. From three to five per cent. of the steam generated is used in the pulverizers, but, as the evaporative power of the petroleum is found to be fully fifty per cent. greater than that of coal, the net gain is still considerable, apart from the convenience of the liquid fuel in handling, and especially in prompt response to sudden demands for steam.

In the reports above referred to, figures are given only from 1890 to 1894 inclusive, but during that period the consumption of petroleum refuse increased more than one hundred per cent., while the increase in all solid fuels was only twenty-five to thirty per cent.

Swiss Steam Engines.

SWITZERLAND has long been noted for the excellence of the product of its steam-gine builders, and it was naturally expected that some superior examples of steam machinery would be found at the exposition at Geneva.

Full accounts of the engines there exhibited have been given in the *Schweizerisches Bauzeitung* for March 13, 20, and 27, as well as in the *Zeitschrift des Ver. deutscher Ingenieure* for March 6, with numerous illustrations. The leading exhibits were those of Gebrueder Sulzer, of Winterthur, and Escher, Wyss & Co., of Zurich, each firm being represented by several engines. The largest of these was a triple-expansion Corliss engine by Escher, Wyss & Co., of 600 h. p., the valve gear being of the Frikart modification, operating the release of the cut-off by the angular motion of the eccentric rod; but there was nothing new in this engine. The same firm exhibited a compound tandem corliss engine of 285 h. p., coupled direct to a dynamo of the Thury type. This engine was arranged with two eccentrics, of which one, fixed to the shaft, operated all

four of the valves at the low-pressure cylinder, as well as the exhaust valves of the high-pressure, while the other eccentric was connected to a shaft governor and controlled the admission valves only of the high-pressure cylinder. The trip cut-off is thus avoided, and the engine adapted for higher speeds, the one exhibited running at 135 revolutions. An engine of this design of 700 h. p. is used in the electric plant at Zurich with good results. Gebrueder Sulzer exhibited a handsome triple-expansion engine of 500 h. p., constructed with their well-known poppet valve gear. The high-pressure and intermediate cylinders were placed tandem on one side, and the low-pressure on the other, and a small engine was arranged for starting, by a ratchet gear acting upon the rope fly-wheel. Sulzer also exhibited a tandem compound vertical engine with large piston valves, one of these being operated by an eccentric placed in the middle of one of the main bearings, which is divided for the purpose,—an arrangement of doubtful advantage.

One of the most notable machines shown was a powerful compound air-compressor, built by Burckhardt, of Bâle. This consisted of a double-cylinder steam engine, with cylinders of 25-inch bore and 23½-inch stroke, the piston rods being prolonged through the rear cylinder heads to the air cylinders. The high-pressure air cylinder was 20½ inches and the low-pressure 31½ inches in bore, both cylinders being provided with peculiar combination valves. These resembled ordinary plain slide valves, except in having the outlet valves mounted on them, the air admission being controlled mechanically by eccentrics independent of those operating the steam-engine valves, and the discharge valves opening by air pressure. At 90 revolutions this compressor had a capacity of 1,766 cubic feet of air per minute, compressed to 70 pounds per square inch. Altogether, the steam-engine exhibits at Geneva showed that, while Switzerland maintains its already high reputation for excellent design and high-grade workmanship, no new details or principles have been there developed in recent years.

The Production of Very Low Temperatures.

WE have already noticed in these columns Prof. Linde's apparatus for the production of very low temperatures and the liquefaction of various gases,—among them, atmospheric air. Prof. Linde contributes a full discussion and description of his apparatus and its operation, together with some investigation of the resulting products, to *Glaser's Annalen* for March 15 and April 1; and, as the whole forms an important contribution to mechanical physics, it is worthy of further notice here.

After exhibiting diagrams showing the behavior of various gases under compression at different temperatures, Prof. Linde reviews the methods heretofore used for reaching the critical points of gases. The experiments of Cailletet, Pictet, and Dewar are described, and the complicated nature of the methods involving successive cooling by means of previously-liquefied gases is shown.

The idea of using air compressed, the heat of compression removed and the expanding air used to cool a fresh quantity of compressed air, is shown to have been first suggested by William Siemens in 1857, and subsequently revived by other investigators. Especial mention is made of Solvay, whose experiments between 1885 and 1895 showed that, although by this method theoretically any temperature down to that at which the gas liquefies should be attainable, yet a point was reached at which the losses equalled the gains, below which further progress could not practically be made. In a memoir presented to the Paris Academy by Cailletet in 1895 it was shown that at a temperature of—95° C. (—194° F.) the further abstraction of heat ceased.

Prof. Linde's new apparatus is a continuous one, the air being compressed and cooled by water to the temperature of the atmosphere, and then allowed partially to expand as it passes through a coil of pipe to a receiver. The coil is surrounded by a second coil, and in the space between the two pipes a portion of the expanded air is allowed to return to the compressor. The

returning air is cooled by contact with the exterior of the coil in which the expansion is taking place, and thus the compressor is constantly receiving colder and colder air, the action being cumulative, much like the self-excitation of a dynamo, until the critical temperature is passed, when the liquefied air is delivered into the receiver. A second compressor is then used to furnish air to make up for that withdrawn as liquid, and the process goes on continuously. The time required for the reduction of temperature is about two hours, after which the apparatus furnishes about one liter of liquefied air per hour continuously.

Among the researches which Prof. Linde has made are included determinations of the specific heat of air at various low temperatures and high pressures. He has also determined the theoretical and actual thermodynamic efficiency of the apparatus for various ranges of temperature, and shows an independent apparatus for the separation of mixed gases of different vaporizing temperatures by a sort of fractional distillation. In connection with this operation it is of interest to note that, in falling from a pressure of 22 atmospheres to 1 atmosphere, the portion of liquid air which vaporized was so largely composed of nitrogen as to leave a liquid composed of 70 per cent. of oxygen.

Improvements in Sterilization.

THE completeness with which disease-germs may be destroyed by the action of heat is well known, and many forms of apparatus have been devised for use in the convenient subjecting of food-constituents either to the boiling-point or, in the system of Pasteurization, to a temperature of 75° C., for a definite period of time. It has been found, however, that with many substances, such as milk, beer, wines, and others, the operation of sterilization partakes of the nature of cooking, imparting a peculiar taste, and sometimes materially changing the properties to an undesirable extent.

In a note recently presented to the Academy of Sciences by M. Duclaux, and given in *La Revue Technique* for April 10, the process of M. Kuhn is described as successfully removing this objectionable feature of sterilization in a very simple manner. The principle consists merely in subjecting the liquid to be sterilized to the desired temperature in a closed vessel under high pressure and out of contact with air. The apparatus is equally simple, the sterilizer being a steel tube silvered within, and surrounded by a steam or water jacket formed of a second cylinder of slightly larger dimensions. Suitable connections and stop cocks are provided, as well as thermometers and pressure-gages, and the apparatus is mounted so that it can be revolved by turning a crank.

The liquid to be sterilized—milk, for example—is introduced into the inner cylinder, the air being allowed to escape by a cock at the top, and great care being taken to have the vessel entirely filled and all the air driven out. The cocks being then closed, a current of warm water is allowed to flow through the space within the surrounding jacket, the temperature being gradually raised to the desired point, and maintained there as long as desired. The cylinder is at the same time slowly revolved, in order to distribute the heat throughout the mass of the liquid. When the sterilization is fully accomplished, the current of water is slowly cooled, until finally ice-water is passed through the jacket, thus removing all the heat from the sterilized liquid before the cylinder is opened. Under these conditions it is found that no change occurs in the condition of the material, and no taste of cooking or boiling, is imparted to it, it being impossible to distinguish milk thus sterilized from that which has not undergone the operation.

The principle of the method is explained in the following manner. The cylinder being entirely filled with the liquid, there is no room left for expansion. As the temperature rises, the attempted dilatation of the milk, being restrained by the confined space, causes a marked increase in pressure, which, for the temperatures of Pasteurization or sterilization, will reach five to six atmospheres. At such pressures the gaseous and aromatic constituents are

unable to separate from the liquid. After the sterilization has been accomplished, the cooling under pressure causes these same constituents, which may have become temporarily dissociated, to be entirely reabsorbed, thus delivering the liquid in practically the same condition as before, except for the destruction of the germs by the heat.

It is believed that this apparatus will be of especial value in the production of wines, since it enables the fermentation to be arrested at any desired stage; and, when used in connection with microbiological investigations, it should be most valuable.

Electric Street Railways in Germany.

THE present status of the electric tramways in Germany is discussed by Dr. Gustav Rasch of Karlsruhe in the *Zeitschrift des Vereines deutscher Ingenieure.* The opinion is expressed that in locations where overhead wires are objectionable the storage battery offers greater advantages than underground conductors, both as regards first cost and economy of operation. The loss of time and labor incurred in charging batteries every trip is likely to be obviated by improvements which will enable one charge to operate a car for a day's run, the experiments made in the line of larger accumulator plates by the Hagen Accumulator works having been especially successful.

Notwithstanding the extensive use of overhead wires with return through the rails, there has as yet been no electrolytic action observed upon water- and gas-pipes in Germany, and, with currents of five hundred volts, but few accidents have occurred, and those in cases of peculiar negligence.

At the present time there are in Germany 227 miles of electric tramways in operation, with 560 motor cars and 450 trailers. The total electric mileage of Europe is now about 440 miles, so that Germany is far ahead of any other country. The following table shows the distribution of mileage by countries: Germany, 52 per cent.; France, 14 per cent.; England, 11 per cent.; Austro-Hungary, 6 per cent.; Switzerland, 5 per cent.; Belgium, 3 per cent.; Italy, 3 per cent.; Spain, 2 per cent.; Russia, 1 per cent.; Servia, 1 per cent.; Norway and Sweden, 1 per cent.; Roumania, 1 per cent.

Steam Superheating Apparatus.

THE revival of interest in superheated steam is giving renewed impetus to various devices for overcoming the defective points in apparatus for accomplishing moderate superheating with reasonable control of temperature.

In the *Oesterr. Zeitschr. f. Berg- u. Hüttenwesen* for February 27 is given an illustrated description of Hering's superheater, in which an attempt is made to obtain a uniform degree of superheating in a simple manner.

The superheating tubes, instead of being placed directly in the flue leading from the boiler, are placed in a sort of oven constructed above the boiler, and arranged so that, by manipulation of dampers, the discharge of gases from the flues can be caused partially or entirely to pass over the superheater.

When the boiler is steaming but moderately, and the flow of steam is small, the furnace gases can be entirely diverted from the superheater and sent to the chimney direct, the superheater tubes lying in a chamber of hot gases without danger of overheating; and from this degree of quiescence to the full intensity of the temperature of the discharge from the boiler-flues any desired degree can be obtained, merely by turning the regulating dampers which control the effective flue area.

Herr Hering shows two forms of superheater, both of which are familiar, one being composed of small bent tubes connected to manifolds similar to steam-heating coils in drying closets, and the other consisting of a system of annular chambers each formed by placing one tube within another; but it is evident that the sensible arrangement of the location of the superheater, with proper flues and dampers, may be applied to any form of apparatus, thus placing the superheating under much better control then when the tubes are placed directly in the flue.

A New Pyrometer.

THE increasing use of high temperatures in the arts, and the desirability of obtaining some simple, and at the same time reasonably accurate, apparatus for measuring such temperatures, is undoubtedly the cause of the advances made recently in different forms of pyrometers. The latest candidate for favor is the invention of M. Latarche, and is called by him the "Actinometric" pyrometer, a description of it being given in *La Revue Technique* for April 10, from which we condense the essential points.

Briefly, the apparatus depends upon the radiant heat emitted by the furnace or other source of heat to be measured, and consists of two thermometers so placed that the rays of heat may impinge upon the bulbs from such a distance that the actual temperatures indicated will fall within the limits of the ordinary scale. The bulb of one thermometer is silvered, and that of the other is blackened; hence there is a marked difference in their respective heat-absorbing capacities, and, therefore, the temperatures which they indicate will not be the same. From this difference the actual temperature of the radiating source of heat may be computed, the principle being analogous to the measurement of a distance by observing two angles at the extremities of a base of known length, the base in this case being the difference in the readings of the two thermometers. A third thermometer, the bulb of which is immersed in water so as to be screened from the action of the radiant heat, is used to give the actual temperature of the surrounding air, and, when a given set of instruments has once been calibrated, the scales may be so graduated that the furnace temperatures may be read off directly.

While the principle of the apparatus is undoubtedly sound, it is evidently adapted only to those cases in which the furnace may be exposed to the view, so to speak, of the instrument. There are, however, many locations in which the Latarche pyrometer will undoubtedly be of much service, and, since it is already in practical use in France, we may soon look for its application in this country as well.

Gas Motors for Tramways.

TRIALS, recently made in Germany, of the latest form of gas locomotive give interesting data as to the economy, speed, and general performance of this type of tramway motor. Details of the test are given in the *Mitt. d. Ver. f. d. Forderung des Local- u. Strassenbahnwesens* for February. The trial run was made between Dellnau and Oranienbaum, on the road from Dessau to Worlitz, the round trip being 17¼ miles, with a grade of 1 in 100 for one-half of the distance. The motor car, which was separate from the passenger carriage, contained a gas engine constructed by the Otto works at Deutz, and tanks for holding the gas, the total weight of the motor car being about eight tons. Including the motor, the total load hauled was about seventeen tons, and the speed ranged from six to fifteen miles per hour.

The total gas-consumption for the round trip of 17¼ miles, including the small consumption during the preliminary manipulation, was 345 cubic feet; at the price of 81 cents per 1,000 feet, the cost of the gas consumed by the trip was 28 cents. As a general result of the experiments, the consumption in regular service was shown to be from three-quarters to one cubic foot of gas per ton-mile. The capacity of the motor for gas and circulating water was sufficient for a trip of twenty-five miles; hence for longer lines either intermediate sources of gas-supply or greater tank-capacity must be provided. While the use of gas motors for tramway purposes is yet in its infancy, the economy is such as to render this application an inviting field for improvement in other respects, and, with the further introduction of cheap fuel-gas, the subject will become still more important.

The Regulation of Steam-Engines.

THE determination of the proper weight for fly-wheels usually involves the assumption of a certain coefficient of steadiness, called by different names in different text-books, and varying between wide limits, according to the closeness of regulation required. The selection of this coefficient is generally left to the judgment and ex-

perience of the designer, and the otherwise simple mathematical relation which the weight of the wheel bears to the other elements of the engine is thus converted into a rather empirical formula. Prof. Moriz Kohn, in the *Zeitschr. des Oesterr. Arch. und Ing. Vereines* for March 12, discusses the other side of this question by determining the degree of irregularity which any given proportions will cause, thus enabling the choice of the proper coefficient of steadiness to be computed with a certain degree of precision.

The data used for the determination of the degree of unsteadiness are found in the indicator diagram, with which is combined the so-called inertia curve, first introduced into steam-engine computation by Mr. Charles T. Porter, and now so generally used in all high-speed engine investigations. By combining the forces acting in one direction with the resistances opposing their action, all the forces being reduced to a common point of rotation, the nature and degree of the inequalities to be overcome are very clearly shown, and the extent to which these can be regulated by a fly-wheel of given dimensions is then a matter of exact computation. Prof. Kohn's paper contains such diagrams, very carefully worked out, together with examples applied to irregular action such as is found in the gas engine, and an example of the application of the method to a compound engine. In the case of a projected engine the general type of indicator diagram may be used, as derived from the conditions under which the engine is intended to be operated.

German Stationary Boilers.

AT the Nuremberg exhibition last year there were a number of steam boilers in use (now illustrated and described in the *Zeitschr. des Vereines deutscher Ingenieure* for March 20), which are interesting as examples of a type formerly much in use in this country and known as the "double-deck" boiler.

While in the main these boilers are of the same general construction as the American generators, yet there are important differences. The old "double-deck" boiler consisted of a lower shell, generally fired beneath, and filled with tubes in the same manner as an ordinary tubular boiler, while above it, and connected by two or more necks, was another shell, about which the gases played on their way to the chimney. The water-level being carried in the upper shell, there was a large extent of efficient heating surface, and the arrangement gave in many cases high evaporative results.

The German boilers exhibited at Nuremberg are internally fired, the lower shell, which is from 7 to 10 feet in diameter, having one or two corrugated furnaces, one example having also Galloway tubes in the rear of the furnace. The upper shell contains a large number of small tubes, through which the gases pass, returning over the top to the chimney.

In these boilers, however, each shell has its own independent water-level, the single connection passing from the steam space of the lower shell through the water space of the upper shell, and the steam from both being taken off through an upper dome. By having a single connection all strains from unequal expansion of the two shells are avoided, this having been found to be a prolific source of danger in the old construction; and, as each shelf has its own feed connection and there is no connection between them below the water lines, each has its own independent circulation.

Tests of a boiler of this construction, built by the *Maschinenbau-Aktien-Gesellschaft* of Nuremberg, formerly Klett & Co., showed an evaporation of 2.66 pounds of water per square foot of heating surface per hour from a temperature of 111° F., and a pound of coal containing 13,300 heat units gave an evaporation equivalent to 9.34 pounds of water from 32° F., evaporated at 212° F., corresponding to an efficiency of 80 per cent.

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Colliery Guardian. *w.* 27*s.* 6*d.* London.
Compressed Air. *m.* $1. New York.
Comptes Rendus de l'Academie des Sciences. *w.* Paris.
Contemporary Review. *m.* $4.50. London
Deutsche Bauzeitung. *b-w.* 15 marks. Berlin.
Dingler's Polytechnisches Journal. *w.* 43.60 marks. Stuttgart.
Domestic Engineering. *m.* $2. Chicago
Electrical Engineer. *w.* 19*s.* 6*d.* London.
Electrical Engineer. *w.* $3. New York
Electrical Engineering. *m.* $1. Chicago.
Electrical Review. *w.* 21*s.* 8*d.* London.
Electrical Review. *w.* $3. New York.
Electrical World. *w.* $3. New York.
Electrician. *w.* 24*s.* London.
Electricity. *w.* $2.50. New York.
Electricity. *w.* 7*s.* 6*d.* London.
Elektrochemische Rundschau. *b-m.* 9.50 marks. Frankfurt.
Elektrochemische Zeitschrift. *m.* 18.40 marks. Berlin.
Elektrotechnisches Echo. *w.* 12 marks. Magdeburg.
Elektrotechniker. *b-m.* 12 marks. Vienna.
Elektrotechnischer Anzeiger. *s-w.* 10 marks. Berlin.
Elektrotechnische Zeitschrift. *w.* 25 marks. Berlin.
Engineer, The. *s-m.* $2. New York.
Engineer, The. *w.* 36*s.* London.

Engineers' Gazette. *m.* 8*s.* London.
Engineering. *w.* 36*s.* London.
Engineering Assns. of the South. Nashville.
Engineering and Mining Journal. *w.* $5. N. Y.
Engineering Journal. *s-m.* 50 cts. Stanford Univ.
Engineering Magazine. *m.* $3. New York.
Engineering-Mechanics. *m.* $2. Phila.
Engineering News. *w.* $5. New York.
Engineering Record. *w.* $5. New York.
Eng. Soc. of the School of Prac. Sci. Toronto.
Eng. Soc. of Western Penn'a. *m.* $7. Pittsburg.
Fire and Water. *w.* $3. New York.
Forester, The. *bi-m.* 50 cts. May's Landing, N.J.
Fortnightly Review. *m.* $4.50. London.
Forum, The. *m.* $3. New York.
Foundry, The. *m.* $1. Detroit.
Garden and Forest. *w.* $4. New York.
Gas Engineers' Mag. *m.* 6*s.* 6*d.* Birmingham.
Gas World, The. *w.* 13*s.* London.
Gesundheits-Ingenieur. *s-m.* 16 marks. München.
Glasers Annalen für Gewerbe und Bauwesen. *s-m.* 20 marks. Berlin.
Gunton's Magazine. *m.* $2. New York.
Harper's Weekly. *w.* $4. New York.
Heating and Ventilation. *m.* $1. New York.
Ill. Carpenter and Builder. *w.* 8*s.* 8*d.* London.
India Rubber World. *m.* $3. New York.
Indian and Eastern Engineer. *w.* 20 Rs. Calcutta.
Indian Engineering. *w.* 18 Rs. Calcutta.
Industries and Iron. *w.* £1. London.
Inland Architect. *m.* $5. Chicago.
Iron Age, The. *w.* $4.50. New York.
Iron and Coal Trade Review. *w.* 30*s.* 4*d.* London
Iron & Steel Trades' Journal. *w.* 25*s.* London
Iron Trade Review. *w.* $3. Cleveland.
Jour. Am. Soc. Naval Engineers. *qr.* $6. Wash.
Journal Assoc. Eng. Society. *m.* $3. St. Louis.
Journal Franklin Institute. *m.* $5. Phila.
Journal of Gas Lighting. *w.* London.
Jour. N. E. Waterw. Assoc. *q.* $2. New London.
Journal Political Economy. *q.* $3. Chicago.
Journal Royal Inst. of Brit. Arch. *s-q.* 6*s.* London.
Journal of the Society of Arts. *w.* London.
Journal of the Western Society of Engineers. *b-m* $2. Chicago.
Kansas University Quarterly. *qr.* $2. Lawrence Kan.
La Nature. *w.* 24.50 francs. Paris.
La Révue Technique. *b-m.* 28 francs. Paris.
L'Eclairage Electrique. 60 fr. Paris.
Le Génie Civil. *w.* 45 fr. Paris.
L'Electricien. *w.* 25 fr. Paris.
Le Moniteur des Architectes. *m.* 33 francs. Paris.
Le Moniteur Industriel. *w.* 40 francs. Paris.
Locomotive Engineering. *m.* $2. New York.
Machinery *m.* $1. New York.
Machinery. *m.* 2*s.* London.
Manufacturer's Record. *w.* $4. Baltimore.
Marine Engineer. *m.* 7*s.* 6*d.* London.
Marine Engineering. *m.* $2. New York.
Master Steam Fitter. *m.* $1. Chicago.
Mechanical World. *w.* 8*s.* 8*d.* London
McClure's Magazine. *m* $1. New York.
Metal Worker. *w.* $2. New York.
Mining and Sci. Press. *w.* $3. San Francisco
Mining Industry and Review. *w.* $2. Denver.
Mining Journal, The. *w.* £1. 8*s.* London.
Mittheilungen des Vereines für die Förderung des Local- und Strassenbahnwesens. *m.* fl. 12. Vienna.
Monatsschrift des Württ. Vereines für Baukunde. 10 parts yearly. 3 marks. Stuttgart.
Moniteur Industriel. *w.* 40 francs. Paris.
Municipal Engineering. *m.* $2. Indianapolis.
National Builder. *m.* $3. Chicago.
Nature. *w.* $7. London.
New Science Review, The. *qr.* $2. New York.
Nineteenth Century. *m.* $4.50. London
North American Review. *m.* $5. New York.
Oesterreichische Monatsschrift für den Oeffentlichen Baudienst. *m.* 14 marks. Vienna.
Oesterr. Zeitschrift für Berg- & Hüttenwesen. *w.* 24 marks. Vienna.
Physical Review, The. *b-m.* $3. New York.
Plumber and Decorator. *m.* 6*s.* 6*d.* London
Popular Science Monthly. *m.* $5. New York
Power. *m.* $1. New York.
Practical Engineer. *w.* 10*s.* London.
Proceedings Engineer's Club. *q.* $2. Phila.
Proceedings of Central Railway Club.
Pro. of Purdue Soc. of Civ. Engs. *yr.* 50 cts. La Fayette, Ind.
Progressive Age. *s-m.* $3. New York.
Railroad Car Journal. *m.* $1. New York.
Railroad Gazette. *w.* $4.20. New York.
Railway Age. *w.* $4. Chicago.
Railway Magazine. *m.* $2. New York.
Railway Master Mechanic *m.* $1. Chicago.
Railway Press, The. *m.* 7*s.* London.
Railway Review. *w.* $4. Chicago.
Railway World. *m.* 5*s.* London.
Review of Reviews. *m.* $2.50. New York.
Safety Valve. *m.* $1. New York.
Sanitarian. *m.* $4. Brooklyn.
Sanitary Plumber. *s-m.* $2. New York.
Sanitary Record. *m.* 10*s.* London.
School of Mines Quarterly. $2. New York.
Schweitzerisches Bauwesen. *w.* 20 marks. Zurich.
Science. *w.* $5. Lancaster, Pa.
Scientific American. *w.* $3. New York.
Scientific Am. Supplement. *w.* $5. New York.
Scientific Machinist. *s-m.* $1.50. Cleveland, O.
Scribner's Magazine. *m.* $3. New York.
Seaboard. *w.* $2. New York.
Sibley Journal of Eng. *m.* $2. Ithaca, N. Y.
Southern Architect. *m.* $2. Atlanta.
Stahl und Eisen. *s-m.* 20 marks. Dusseldorf.
State's Duty, The. *m.* $1. St. Louis.
Stationary Engineer. *m.* $1. Chicago.
Steamship. *m.* Leith, Scotland.
Stevens' Indicator. *qr.* $1.50. Hoboken.
Stone. *m.* $2. Chicago
Street Railway Journal. *m.* $4. New York.
Street Railway Review. *m.* $2. Chicago.
Technology Quarterly. $3. Boston.
Tradesman. *s-m.* $2. Chattanooga, Tenn
Trans. Assn. Civil Engs. of Cornell Univ. Ithaca.
Trans. Am. Ins. Electrical Eng. *m.* $5. N. Y.
Trans. Am. Ins. of Mining Eng. New York.
Trans. Am. Soc. Civil Engineers. *m.* $10. New York.
Transport. *w.* £1. 5*s.* London.
State's Duty, The. *m.* $1. St. Louis.
Western Electrician. *w.* $3. Chicago.
Western Railway Club, Pro. Chicago.
Wiener Bauindustrie Zeitung. *w.* 27 marks. Vienna.
Wisconsin Engineer. *qr.* $1.50. Madison, Wis.
Yale Scientific Monthly, The. *m.* $2.50 New Haven.
Zeitschrift für Lokomotivführer. *m.* 5 marks. Hannover.
Zeitschrift für Maschinenbau & Schlosserei, Berlin.
Zeitschrift des Oesterreichischen Ingenieur und Architekten Vereines. *w.* 53 marks. Vienna.
Zeitschrift des Vereines Deutscher Ingenieure. *w.* 32 marks. Berlin.
Zeitschrift für Elektrochemie. *s-m.* 16 marks. Halle, a. S.
Zeitschrift für Elektrotechnik. *s-m.* 16 marks. Halle a. S.
Zeitschrift für Instrumentenkunde. *m.* 20 marks. Berlin.

ARCHITECTURE AND BUILDING.

CONSTRUCTION AND DESIGN.

ARCHES.

Note on the Strength of Arches between Rolled Beams. (Ein Beitrag zur Reform der Gewölbstärken zwischen Walzträgern.) Discusses the twisting action which the arches exert upon the beams and the risks which are incurred by neglecting it. 1000 w. Zeitschr d Oesterr Ing u Arch Ver—April 2, 1897. No. 12717. 30 cts.

AUSTRIA.

Austrian Architecture. (Wiener Bauten Album.) Plates and descriptive text of buildings in Graz and Vienna. Photogravures. 1500 w. and 5 plates. Wiener Bauindustrie Zeitung—April 1, 1897. No. 12784. 45 cts.

BANK Building.

The Most Unique and Complete Banking Building in America. Illustrated detailed description of the Illinois Trust and Savings Bank, in Chicago. 10000 w. In Arch—May, 1897. No. 13156. 45 cts.

BARRACKS.

Knockdown and Portable Dwellings. (Ueber Zerlegbare und Transportable Wohnhäuser.) Devoted chiefly to the construction of portable barracks for military use. 5000 w. and 1 plate. Zeitschr d Oesterr Ing u Arch Ver—April 23, 1897. No. 12722. 30 cts.

CHURCHES.

Double-aisled Churches. (Ueber Zweischiffige Kirchenbauten.) A discussion of church design with wide nave and aisle on one side, with illustrations of buildings so altered. 4500 w. Zeitschr. d Oesterr Ing u. Arch Ver—April 30, 1897. No. 12724. 30 cts.

Village Churches. G. G. Scott. Discusses the importance of the site, the tower, the chancel, chancel screens, &c. 6000 w. Arch, Lond—May 14, 1897. No. 13102. 30 cts.

COLUMN.

See Civil Engineering, Miscellany.

CONGRESSIONAL Library.

The New Library of Congress. Montgomery Schuyler. Interesting illustrated description of the architectural features. 7000 w. Scribner's Mag—June, 1897. No. 13108. 30 cts.

See same title under Heating and Ventilation.

PAINTING.

The Painting of Metallic Structures. Comments on information given by A. H. Sabin, formerly professor of chemistry in the University of Vermont, on the constitution of paints, and the results of important experiments. 1500 w. Engng—May 14, 1897. No. 13079. 30 cts.

EXPOSITION.

The World's Columbian Exposition. Arthur Peabody. A study of the constructive problem and its value as a criterion. The general design, buildings, construction, materials and methods. 8500 w. Technograph—No. XI. No. 13033. 45 cts.

FIREPROOF Construction.

Fireproof Building Construction in the Pittsburg, Pa., Fire. Account of the origin and progress of the fire, the burned buildings, and views showing the effects on fireproof construction, and editorial containing suggestions to engineers and architects. 6000 w. Eng News—May 20, 1897. No. 12998. 15 cts.

Fireproofing Tests. Describes an interesting test at the proving ground at 68th St. and Avenue A, New York, conducted after the requirements of the New York Dept. of Buildings. The arched or flat-domed floor, built after Mr. Guastavino's method of cohesive construction, was submitted to a test of unusual severity. 1600 w. Am Arch—May 8, 1897. No. 12826. 15 cts.

Official Test of Fireproof Floor Construction Systems. Report of the test of the "Metropolitan" system. Ill. 1800 w. Eng Rec—May 29, 1897. No. 13184. 15 cts.

An Instructive Fire in Pittsburg, Pa. An illustrated account of the large fire in Pittsburg, interesting as giving an opportunity of judging of the value of modern methods of fireproofing. 2200 w. Eng Rec—May 22, 1897. No. 13084. 15 cts.

FLOORS.

Floors. Fred T. Hodgson. Editorial on the requisites of a good floor, and how to construct one; bridging, causes of weakness, &c. 1400 w. Nat Build—April, 1897. Serial. 1st part. No. 12821. 30 cts.

FOUNDATIONS.

Eccentric Loads on Foundations. F. L. Douglas. The purpose of the article is to show an easy method for obtaining the maximum pressure under the heel of the footing, and applies to all cases where footings rest directly upon the earth, and also where grillage beams are used to distribute the loads over greater areas, and when slightly modified may be used in obtaining the proportion of total load carried by each of the several lower grillage beams when the loads are not symmetrically placed. 700 w. Eng News—May 20, 1897. No. 12994. 15 cts.

FRAMEWORK.

Notes on Framework in Space. (Bemerkungen über Räumliches Fachwerk.) A geometrical investigation of some of the points involved in the design of trussed domes, conical roofs, and framed structures in three dimensions. 5000 w. Zeitsch d Ver Deutscher Ing—April 24, 1897. No. 12709. 30 cts.

HOSPITALS.

The Construction of Hospitals. William Henman. Read before the Liverpool Archt. Soc. Deals principally with the design of large town hospitals, discussing all important details. Ill. 5800 w. Jour Roy Inst of Brit Archts—May 6, 1897. No. 13222. 30 cts.

IMITATION.

Imitation in Architecture. A. C. Munoz. Published in the Philadelphia *Times*, and reproduced as an excellent example of the general direction pursued by modern thought in regard

to present-day architectural design. 3400 w. In Arch—May, 1897. No. 13158. 45 cts.

MASONRY.

Broken Ashlar Masonry. W. W. Beach. Illustrations and discussion of the possibilities of this form of masonry. 1400 w. Technograph. No. XI. No. 13035. 45 cts.

NORTHAMPTON, England.

The Architecture of Our Large Provincial Towns Illustrated description of the architecture of Northampton, with historical accounts of some of the buildings. 6600 w. Builder—April 24, 1897. No. 12620. 30 cts.

OBSERVATORY.

The Observatory Tower of Stolberg. (Der Aussichtsturm auf der Josephshöhe bei Stolberg am Harz.) A handsome iron lookout tower, 118 feet high. The top is in the form of a horizontal Greek cross with four large projecting balconies. 1200 w. Zeitschr d Ver Deutscher Ing—April 10, 1897. No. 12704. 30 cts.

ROTARY Buildings.

Portable and Rotary Buildings. (Edifice Démontable Rotatif.) Detailed description of the rotating house which it is proposed to construct for the exposition of 1900. 2500 w. La Revue Technique—April 25, 1897. No. 12736. 45 cts.

STYLE.

The Fundamentals of the Development of Style. Peter B. Wight. An address before the Chicago Architectural Club. A talk on what the author considers necessary for the foundation of style. 4500 w. In Arch—May, 1897. No. 13157. 45 cts.

TALL BUILDINGS.

Engineering Problems of the Tall Building. Charles O. Brown. Reviewing the leading features adopted in the erection of "Skyscrapers." Ill. 3800 w. Eng Mag—June, 1897. No. 13264. 30 cts.

THEATRE.

The Reconstruction of the Vienna Burgtheatre. (Die Reconstruction des Burgtheatres.) A criticism of the numerous defects of the building, by Prof. Prokop, with suggestions for its interior reconstruction, and incidentally many useful notes on theatre construction in general. 4500 w. Zeitschr d Oesterr Ing u Arch Ver—May 14, 1897. No. 12729. 30 cts.

VAULTS.

Modern Vault Construction. John Beverley Robinson. Illustrated detailed description of the requirements and construction of vaults, attacks on vaults, &c. 4400 w. Arch Rec—April-June, 1897. No. 12623. 30 cts.

WALLS.

Walls and Ceilings of Hollow Bricks of Cement and Plaster. (Wände und Decken aus Cement- und Gyps-Hohltafeln.) A review of Continental practice, with data concerning loads and sustaining power. Two articles. 5000 w. Wiener Bauindustrie Zeitung—April 15 & 22, 1897. No. 12786. 45 cts. each.

WINDOWS.

Decorative Windows in England and America. Russell Sturgis. Interesting review of a book by Henry Holiday entitled "Stained Glass as an Art." 5000 w. Arch Rec—April-June, 1897. No. 12625. 30 cts.

WOODEN Houses.

Wooden Houses in Switzerland. Jean Schopfer. An interesting illustrated description of the exhibition of Swiss châlets of various epochs, at the Geneva National Exposition of 1896. The "Swiss Village" was arranged on historical lines, each house exists, or did exist, in reality. 3200 w. Arch Rec—April-June, 1897. No. 12622. 30 cts.

WORKMEN'S Homes.

Improved Housing for the Poor. Ella Hood Cooper. Suggests a plan by which many of the evils of the present system of tenement house construction may be mitigated. 2000 w. Gunton's Mag-June, 1897. No. 13252. 30 cts.

Uninhabitable Dwellings. Hugh R. Jones. Extract from a paper read at meeting of the Sanitary Inspectors of Carnarvonshire and District. Discusses the problem of housing satisfactorily the "wage-earning" classes. 3500 w. San Rec—April 30, 1897. No. 12802. 30 cts.

ZURICH.

Buildings for the Old Tonhalle Place in Zurich. (Bebauungsplan des Areals der Alten Tonhalle in Zurich.) Handsomely illustrated account of Prof. Bluntschli's admirable design for the occupation of a most valuable building location. 2500 w. 1 plate. Schweizerische Bauzeitung—April 17, 1897No. 12749. 30 cts.

HEATING AND VENTILATION.

CONGRESSIONAL Library.

Heating and Ventilation of the Congressional Library. Part first gives an illustrated general description, floor plans, and distribution of flow and return pipes. 2400 w. Eng Rec—May 1, 1897. No. 12599. 15 cts.

CENTRAL Station.

Central Station Heating System at Fredonia, N. Y. Illustrated description of the heating of a number of buildings from the engines of the electric railway plant, using the exhaust steam, and in extreme weather by live steam injected from same plant. 1200 w. Heat & Ven—May 15, 1897. No. 12970. 15 cts.

SCHOOL.

Heating, Ventilating and Plumbing the Grammar School at Saugus, Mass. Illustrated detailed description. 2300 w. Met Work—May 8, 1897. No. 12614. 15 cts.

Heating and Ventilation of Public School No. 14, Erie, Pa. Floor plans and description clearly show the arrangement of the system. 600 w. Heat & Ven—May 15, 1897. No. 12971. 15 cts.

Notes on Heating of Schools. (Einiges über Schulheizung.) Discussing the various methods employed in Germany, including stoves, steam, hot water and hot air. Three articles. 10,000 w. Gesundheits Ingenieur—April 15, 30, May 15, 1897. No. 12777. 60 cts.

STEAM Heating.

Hints on Steam-Heating. M. O. Kasson. Calls attention to loss of heat from position of radiators, or from covering tops of radiators, and various other practices. 2400 w. Sta Eng—May, 1897. No. 12656. 15 cts.

Laying up Steam-Heating Plants. W. H. Wakeman. Caring for the boilers and appliances which must remain out of use. 800 w.

Am Mach—May 6, 1897. No. 12662. 15 cts.

Some Points on Steam Heating. F. A. Camp. From a paper read before the Minnesota Archt. Assn. Explains what steam is and how made, the importance of a good draft, and of a good circulation. 1800 w. San Plumb—May 1, 1897. No. 12638. 15 cts.

LANDSCAPE GARDENING.

FLORICULTURE.

The Hardy Flower Garden. A. Herrington. Read at meeting of the New Jersey Floricultural Soc. Extract giving suggestions for a garden that shall bloom with the advancing seasons, with lessons from nature. 1800 w. Gar & For—May 19, 1897. No. 12935. 15 cts.

LANDSCAPE-Gardening.

Art and Nature in Landscape-gardening. Editorial on the importance of obtaining the counsel of a landscape-gardener of recognized standing, rather than attempting to work out one's own ideas. 1200 w. Gar & For—May 19, 1897. No. 12934. 15 cts.

PARKS.

The True Purpose of a Large Public Park. John C. Olmsted. Extract from a paper read before the Park and Outdoor Art Assn. of Louisville, Ky. Considers the purpose is to provide for city dwellers an opportunity to enjoy natural scenery and find relief from the nervous strain of city life. Opposes anything that interferes with this purpose. 2200 w. Gar & For—June 2, 1897. No. 13221. 15 cts.

The Way to Make Parks Attractive. Editorial suggestions as to arrangement of flowering shrubs, small trees, &c. 1000 w. Gar & For—May 26, 1897. No. 13116. 15 cts.

SCHOOL Gardens.

School Gardens and School Grounds. Editorial suggested by a leaflet sent out recently by the Cornell Experiment Station inviting each of the school children to plant a little garden of sweet peas and China asters. The work in this line in Germany is cited. 1300 w. Gar & For—May 5, 1897. No. 12631. 15 cts.

PLUMBING AND GASFITTING.

DOMESTIC Plumbing.

Plumbing and House Drainage. Reuben S. Bemis. The importance of this feature in the construction of homes, the dangers of neglect, faults in plumbing of dwellings, with important suggestions. 2700 w. San Plumb—May 1, 1897. No. 12639. 15 cts.

Plumbing, Heating and Ventilating of Claus Spreckels' Mansion in San Francisco, Cal. Description of scientific sanitary improvements in one of the beautiful homes of that city. 3800 w. Dom Engng—May, 1897. No. 13107. 30 cts.

FIRECLAY.

Fireclay Manufacturers. W. H. Allen. Read before the Northern Architectural Assn. Describes the process of manufacture of sanitary pipes and specialties, glazed bricks, scullery sinks, white channel bends, closets, &c. 3300 w. Arch, Lond—April 30, 1897. No. 12810. 30 cts.

PLUMBERS.

The Architect in his Relation to the Plumber. W. J. Burroughs. The importance of the plumber's work, the need of harmony between plumber and architect, and the need of wise legislation. 2500 w. Can Arch—May, 1897. No. 13091. 30 cts.

PLUMBING.

Full Course of Technical Instruction for Plumbers. A series of articles by a registered teacher and first-honors silver-medallist. Part first consists of introduction, and a consideration of duodecimals and mensuration. 2500 w. Dom Engng—May, 1897. Serial. 1st part. No. 13105. 30 cts.

SANITARY Appliances.

Modern Sanitary Appliances for Interior of Dwelling Houses. W. J. Wells. Considers closets, baths, lavatories, cisterns and sinks, with the supplies and wastes from same. 3500 w. Dom Engng—May, 1897. Serial. 1st part. No. 13106. 30 cts.

The Rise and Progress of Sanitary Plumbing. John Glaister. Inaugural address in the Glasgow and West of Scotland Technical College. Part first hastily reviews the early history of plumbing, and gives some account of the history of water-supply in Glasgow. 3000 w. Dom Engng—May, 1897. Serial. 1st part. No. 13104. 30 cts.

MISCELLANY.

ANCIENT Cities.

The Ancient Cities of the Old World. Cyrus K. Porter. The subject is confined to the architecture of Egypt, Assyria and Chaldea as studied in the ruins, with some account of their important cities. 6000 w. Stone—May, 1897. No. 13026. 30 cts.

ARCHITECTURE.

Natural Selection in Architecture. C. H. Blackall. A discussion of the methods of arriving at desired results in architecture. 2500 w. Technograph. No. XI. No. 13028. 45 cts.

The Works of Cady, Berg & Lee. Montgomery Schuyler. Illustrated description of important work by architects named, with brief biographical sketches, and criticism and comment. 8500 w. Arch Rec—April-June, 1897. No. 12626. 30 cts.

BOSTON.

Recent Boston Architecture. Albert Winslow Cobb. The first part is introductory, and also considers the buildings at the memorial and commercial center. Ill. 2000 w. Arch & Build—May 15, 1897. Serial. 1st part. No. 12888. 15 cts.

BRICK and Terra-Cotta.

Brick and Terra-Cotta at the League Exhibition. An illustrated review of the work exhibited at the annual exhibition of the Architectural League of New York. 2200w. Br Build—April, 1897. Serial. 1st part. No. 12621. 30 cts.

BUILDING Stones.

The Building Stones of New England. William Beals, Jr. Illustrated description of the varieties found in each state. 6000 w. Stone—May, 1897. Serial. 1st part. No. 13025. 30 cts.

COLOR.
Color in its Relation to Architecture. Elmer Ellsworth Garnsey. An interesting article presenting the value of color in architecture, the advantage of the study of harmony in color, and many suggestions. 3300 w. Br Build—May, 1897. 30 cts.

FORMAL and Informal Treatment.
The Formal and Informal in Architecture. Discusses the symmetry that distinguishes picturesque beauty from ordinary beauty and illustrates the writer's views. 3000 w. Arch, Lond—April 30, 1897. Serial. 1st part. No. 12811. 30 cts.

HERALDRY.
Heraldry of the Renaissance in England. J. Alfred Gotch. Read at general meeting of the Roy. Inst. of Brit. Archts. A study of the subject from the decorative side. The causes of deterioration in heraldic drawing are reviewed and its uses in historical research. Illustrations and discussion. 5000 w. Jour Roy Inst of Brit Archts—April 1, 1897. No. 12635. 45 cts.

HOUSES.
Houses for Homes. Considers how best to house the happy home. Makes suggestions for the planning of a city house. 1800 w. Nat Build—May, 1897. No. 12918. 30 cts.

LOGARITHMS.
Graphical Logarithmic Tables. (Graphische Logarithmentafeln.) A discussion of the advantages of substituting logarithmic scales in the form of tables for the usual numerical tables. 1200 w. Zeitschr d Oesterr Ing u Arch Ver—May 7, 1897. No. 12726. 30 cts.

MEDIEVAL Architecture.
A Discovery of Horizontal Curves in Medieval Italian Architecture. William H. Goodyear. Describes facts established by the Brooklyn Inst. Survey of 1895, of the discovery of the refinement of curving horizontal lines, generally supposed to be restricted to the temples of the Greeks, in the churches and cloisters of Italy. Ill. 7800 w. Arch Rec—April-June, 1897. Serial. 1st part. No. 12624. 30 cts.

PARIS Fire.
The Lesson of the Paris Fire. Points out the great risk of temporary buildings, and the danger of using rooms unsuited in plan for bazaars, or public entertainments. 1600 w. Builder—May 8, 1897. No. 12945. 30 cts.

The Fire at the Paris Bazaar. Additional information of this catastrophe, with illustrations of site, buildings, plans, &c. 1800 w. Engng—May 14, 1897. No. 13077. 30 cts.

PARTHENON.
How a Riddle of the Parthenon was Unraveled. Eugene P. Andrews. Describes the method of unraveling the riddle of the nail-holes in the architrave of the east front of the Parthenon. Ill. 5500 w. Century Mag—June, 1897. No. 13196. 45 cts.

The Parthenon and the Earthquake of 1894. F. C. Penrose. Read at meeting of Royal Inst. of British Archs. Abstract of paper and discussion. 2000 w. Arch, Lond—May 21, 1897. No. 13183. 30 cts.

RESTORATION.
A Note concerning Correct Restoration. (Ein Wort zur Güte über Restaurien.) Discusses the injuries often wrought to old buildings, monuments, &c., under the guise of restoration, and makes a plea for greater consistency and accuracy. 4500 w. 2 plates. Oesterr Monatschr f d Oeffent Baudienst—April, 1897. No. 12752. 45 cts.

SCHOOL of Architecture.
The Summer School of Architecture for 1896 in Southern England, Normandy, and Touraine. Eleazer B. Homer. Interesting account, beautifully illustrated, of the excursion of the M. I. T. Summer School of Architecture, including about one thousand miles of bicycle travel in Europe. 8500 w. Tech Quar—March, 1897. No. 12908. 75 cts.

SKETCHES.
Architectural Rendering in Pen and Ink. D. A. Gregg. Hints, with illustrations, of this class of work. 1800 w. Br Build—May, 1897. No. 13142. 30 cts.

TALL Buildings.
Weighing of Tall Buildings. Theodore Waters. Finding the exact gravity of huge masses of iron and stone, every bolt, bar, and pane of glass carefully considered; the weight of tenants and casual visitors and even paint and carpets determined. 1800 w. So Arch—May, 1897. No. 12615. 30 cts.

WESTMINSTER Abbey.
The Story of an Illustrious Abbey. A. T. Taylor. Paper presented before the Province of Quebec Assn. of Architects. A very interesting account of Westminster Abbey. 9500 w. Can Arch—May, 1897. No. 13090. 30 cts.

WIND-PRESSURE.
Wind Pressure in St. Louis Tornado. Julius Baier. Facts ascertained from the inspection of the buildings, with general study of the subject. 3200 w. In Arch—May, 1897. No. 13159. 45 cts.

CIVIL ENGINEERING.

BRIDGES.

BRIDGE.
See Railroad Affairs, Maintenance of Way.

CAISSONS.
The East-River Bridge Caissons. Information of the construction of these caissons, one of which is ready to launch. 700 w. Eng Rec—May 15, 1897. No. 12948. 15 cts.

COFFER-DAM.
Deep Coffer-Dam Construction for Bridge Piers, Portland and Rumford Falls R. R. Illustrated description of two coffer-dams built against an unusual head of water and possessing structural features of interest. 800 w. Eng

News—May 27, 1897. No. 13138. 15 cts.

DON.

Bridge Over the River Don. Drawings of the principal members, etc., with description, of a popular type of bridge. 900 w. Eng, Lond—May 21, 1897. No. 13211. 30 cts.

EAST-RIVER Bridges.

Foundations for the Brooklyn Tower of the New East-River Bridge. Gives drawings and descriptions of this work, taken from the official plans and specifications. 2800 w. Eng News—May 27, 1897. No. 13139. 15 cts.

The New York and Long Island Bridge, New York City. Illustrated description of the great steel cantilever bridge by which the Long Is. R. R. Co. expects in due time to run its trains into New York City. 1600 w. Sci Am—May 8, 1897. No. 12643. 15 cts.

FRANCIS-JOSEPH.

The New Francis-Joseph Bridge. The fundamental system of the structure is explained and illustrations and description of the architectural features. The whole appearance of the structure is said to be striking and elegant and to add to the charms of Buda-Pesth. 2200 w. Eng, Lond—May 14, 1897. No. 13073. 30 cts.

LIFT Bridge.

Lift Bridge at Milwaukee. Illustrated description of the Huron St. bridge. 1800 w. Ry Rev—May 15, 1897. No. 12950. 15 cts.

NEWARK.

The Fourth-Street Bridge, Newark. Illustrated description of a heavy solid-floor steel highway drawbridge and approaches to be constructed across the Passaic River. 2000 w. Eng Rec—May 1, 1897. No. 12598. 15 cts.

PAINTING.

See Architecture and Building, Construction and Design.

ROCK Island.

Building the Draw Span of the New Rock Island Bridge. An account of the accident by which this bridge was wrecked by the ice when in process of building, and of its rapid reconstruction. 3400 w. R R Gaz—May 28, 1897. No. 13150. 15 cts.

STRESSES.

See Same title under Mining and Metallurgy, Iron and Steel.

TESTING.

Recent Tests of Bridge Members. J. E. Greiner. Discusses a number of tension tests on bridge members, other than eye-bars, made by the author. These tests are in a channel outside of the usual run, and the results obtained furnish information of interest and value. Ill. 6000 w. Pro Am Soc of Civ Engs—May, 1897. No. 13126. 75 cts.

VIADUCT.

The Mussy Viaduct; Paris, Lyons, and Mediterranean Railway. Illustrates and describes several interesting features. 1100 w. Engng—April 30, 1897. No. 12684. 30 cts.

CANALS, RIVERS AND HARBORS.

BLOCK-SETTING.

40-Ton Block-Setting "Titan." Illustrated description of a machine to be used in the construction of the harbor works at Vera Cruz, Mexico. 1200 w. Engng—May 14, 1897. No. 13076. 30 cts.

BOSTON Harbor.

Boston's Harbor Defects. From the N. Y. *Times*. Development of the ocean trade of that port retarded by shoal water. 1100 w. Sea—June 3, 1897. No. 13247. 15 cts.

CONCRETE.

Concrete as Made on the Trent Canal. H. F. Greenwood. A brief description of the methods used and the precautions taken in constructing some of the works named. Ill. 2500 w. Can. Arch—May, 1897. No. 13089. 30 cts.

CONCRETE Machinery.

Concrete Machinery on the Chicago Drainage Canal. Illustrated description of the machines used on Sections 14 and 15, in building the retaining walls. 1200 w. Eng Rec—May 22, 1897. No. 13082. 15 cts.

DAM.

A New Dam at Minneapolis. H. M. F. Dahl, A general description of the dam built below the falls for the purpose of utilizing the power. Ill. 1700 w. Eng's Year Book, Univ. of Minn, 1897. No. 13010. 45 cts.

Effects of Mississippi River Floods on the New St. Anthony Falls Dam at Minneapolis. Horace B. Hudson. The conditions under which the break occurred are stated, and illustrations showing the appearance of the dam. 700 w. Eng News—May 13, 1897. No. 12877. 15 cts.

DUNKIRK.

Port of Dunkirk.—New Deep-Water Lock. An illustrated account of this lock, which had to be constructed in the immediate neighborhood of existing works on a bed of sand, and under great difficulties. 1800 w. Eng, Lond—May 14, 1897. No. 13072. 30 cts.

FLOODS.

See Railroad Affairs, Miscellany.

Suggestions for the Control of Mississippi River Floods. Samuel McElroy. Suggestions in the line of relief submitted by an expert in various flood cases. 900 w. Eng News—May 20, 1897. No. 12997. 15 cts.

GROYNES.

Groynes and Sea-Coast Defenses. A. T. Walmisley. Read before the Inst. of Municipal and Civil Engs. Maintenance of cliff faces, the retention of a fore-shore, and such works of protection as are necessary to secure the advantages of a seaport. 2500 w. Ind & Ir—April 30, 1897. No. 12694. 30 cts.

HARBOR.

The Conversion of the Danube Canal at Vienna into a Dock and Winter Harbor. (Ueber die Arbeiten zur Umwandlung des Wiener Donaucanals in einen Handels- und Winterhafen.) An elaborately illustrated account of these very important harbor improvements. Two plates of details and numerous illustrations. Two articles. 7500 w. Zeitschr d Oesterr Ing u Arch Ver—April 2 and 9, 1897. No. 12715. 60 cts.

The New Waterways and Land Reclamation at Seattle, Wash. Extracts from a letter of Mr. Eugene Semple, giving interesting information, with editorial comment, calling attention to necessary precautions in this class of work. 2300 w. Eng News—May 27, 1897. No. 13140. 15 cts.

LEVEES.

A New Levee System. Guy M. Walker. Outlines a plan for protecting the banks of the Mississippi, and the advantages of permanent protection. 2000 w. State's Duty—May, 1897. No. 12676. 15 cts.

PIER.

The Public Pier of Panillac. Illustrated description of a fine piece of engineering work which has made it possible for Bordeaux to stand third in rank among the great commercial ports of France. 1800 w. Sci Am Sup—May 15, 1897. No. 12857. 15 cts.

PROPULSION.

See Mechanical Engineering, Power and Transmission.

STETTIN.

The Harbor of Stettin and its Water Communication with the Sea and the Interior. (Ueber die Hafenanlagen Stettins und dessen Wasserverbindungen mit dem Meere und dem Binnenlande.) An account of the important harbor improvements of Stettin, by means of which it is expected to compete with Hamburg and Bremen. Three articles. 4500 w. Deutsche Bauzeitung—April 24, May 1 & 8, 1897. No. 12788. 30 cts. each.

WATERWAYS.

Deep Waterways from the Great Lakes to the Sea. Allan Ross Davis. A review of the Trent Canal project. Ill. 3800 w. Eng Mag—June, 1897. No. 13261. 30 cts.

IRRIGATION.

IRRIGATION.

Irrigation. Guy M. Walker. Reviews the history of irrigation in ancient and oriental countries, and calls attention to its importance in this country, offering suggestions for the raising of the needed funds. 2000 w. State's Duty—June, 1897. No. 13244. 15 cts.

Irrigation in North-west Canada. From the Annual Report of the Dept. of the Interior for 1895. Information of the area of arid region in Canada. 900 w. Ind Engng—April 10, 1887. Serial. 1st part. No. 12842. 45 cts.

MISCELLANY.

AQUEDUCT.

The Construction of the Nussdorf Aqueduct. (Ueber die Art der Ausführung der Alimentations-Canäle bei Nussdorf.) Describing especially the construction of the inverted siphon under the Elbe. 3500 w. Zeitschr d Oesterr Ing u Arch Ver—April 9, 1897. No. 12718. 30 cts.

COLUMN.

The Theory of the Ideal Column. Henry S. Prichard. An analysis of the theory resulting from the application of the ordinary assumptions of flexure to the case of straight columns, with constant cross-section, centrally loaded. The conclusions favor the use of the ordinary empirical formulas. 3000 w. Eng News—May 6, 1897. No. 12679. 15 cts.

The Theory of the Ideal Column. Papers by Messrs. Merriman, Dubois, and Johnson prepared as comments upon the paper with the above title by Henry S. Prichard. 6400 w. Eng News—May 20, 1897. No. 12996. 15 cts.

CONCRETE.

See same title under Canals, Rivers and Harbors.

DAM.

See same title under Municipal Engineering, Water Supply.

ICE Gorge.

Ice Gorge Blasting at Niepolomice. (Die Eissprengung bei Niepolomice.) Describing the effective use of dynamite to remove ice gorges in the Vistula. 5000 w. 1 plate. Oesterr Monatschr f d Oeffent Baudienst—April, 1897. No. 12751. 45 cts.

MASONRY.

See same title under Architecture, Construction and Design.

PAINTING Iron Structures.

See Architecture and Building, Construction and Design.

RACE Tracks.

Race Tracks. How to Build and Repair Them. W. R. Hoag. Discusses the selection of the site, best material for the track, laying out the track, drainage and resurfacing. 2300 w. Eng's Year Book. Univ of Minn—1897. No. 13011. 45 cts.

ROADS.

Drainage of Country Roads. E. A. Whitman. Discusses surface and sub-surface drainage, drains, culverts, &c. 2600 w. Jour Assn of Engng Soc—April, 1897. No. 13020. 30 cts.

European Roads. William R. Hoag. Some reference is made to early road-building, which was begun in England and followed by other countries. The questions of expense and construction are briefly considered. 3000 w. Jour Assn of Engng Soc—April, 1897. No. 13019. 30 cts.

State Roads of Massachusetts. Albert A. Pope. Some information of the work already accomplished in this state. 1500 w. State's Duty—May, 1897. No. 12675. 15 cts.

SOUTH AMERICA.

Engineering in South America. W. C. Weeks. Experiences during several months of exploration of the Orinoco Delta in the Republic of Venezuela. Ill. 2500 w. Eng's Year Book, Univ of Minn—1897. No. 13001. 45 cts.

TOPOGRAPHICAL Surveys.

Topographical Surveys—Methods Used on the Vanderbilt Estate at Biltmore, N. C. John L. Howard. The problem to be solved is stated and the method used described. 2300 w. Jour Assn of Engng Soc—April, 1897. No. 13018. 30 cts.

Topographical Surveys of the Metropolitan Park Reservations of Massachusetts. Henry F. Bryant. Interesting description of the work, with maps. 4800 w. Jour Assn of Engng Soc—April, 1897. No. 13017. 30 cts.

TELEMETRY.

The Opera Glass Telemeter. (La Jumelle Stéréoscopique Stadia-Télémètre.) The relative displacement of the images by means of a combination of prisms enables the distance to be determined directly. Especially intended for military use. 1500 w. La Revue Technique—April 25, 1897. No. 12738. 45 cts.

TUNNEL.

Construction and Cost of the Jungfrau Tunnel. (Ueber den Bau und die Kosten des Jungfraubahn-Tunnelo.) A discussion of the difficulties to be encountered in this bold and interesting piece of Alpine railroading. 2000 w. Schweizerische Bauzeitung—April 10, 1897. No. 12747. 30 cts.

The Blackwall Tunnel. Illustrated description of this interesting engineering work recently completed and opened. 4500 w. Eng, Lond—May 21, 1897. No. 13209. 30 cts.

The Simplon Tunnel. A glance at the various problems, physical, mechanical and economical, that have had to be solved. 1800 w. Nature—April 29, 1897. No. 12699. 30 cts.

The Simplon Tunnel. The latest project for tunneling the Simplon, and present status of the enterprise, as given by M. Jules Michel, in the "Revue Generale des Chemins de Fer." Map and Ills. 1600 w. Eng News—May 27, 1897. No. 13137. 15 cts.

ECONOMICS AND INDUSTRY.

COMMERCE AND TRADE.

BRITISH Competition.

Competition with British Trade Abroad. Memorandum based on information contained in official reports. Calls attention to points of importance to manufacturers and exporters, if they are to hold their share of trade in foreign countries. 4000 w. Bd of Trd Jour—May, 1897. No. 13128. 30 cts.

CANADA.

Our Trade Relations With Canada. John W. Russell. Discusses the desirability and probability of improved trade relations between the United States and Canada. 3000 w. N Am Rev—June, 1897. No. 13219. 45 cts.

CUSTOMS.

Customs Regulations in Brazilian Ports. Instructions to shippers and captains trading with Brazil. 1500 w. Bd of Trd Jour—May, 1897. No. 13129. 30 cts.

INDIA-RUBBER.

The India-Rubber Industry in Europe. Information of interest from various points. 2200 w. Ind Rub Wld—May 10, 1897. No. 12681. 45 cts.

IRON Trade.

The Competitive Basis and Conditions of the American Iron Trade. Franklin Hilton. Read before the annual meeting of the British Iron Trade Assn. Considers iron ore supplies, coal and coke supplies, railway transport, lake, canal and river transport, labor, equipment, royalties, the Carnegie Co.—with conclusions. 4200 w. Ir & Coal Trds Rev—May 21, 1897. No. 13161. 30 cts.

JAPAN.

Industrial and Commercial Conditions in Japan. Editorial discussion of some of the conditions and problems of the industrial movements going on in Japan. 2200 w. Engng—May 7, 1897. No. 12900. 30 cts.

PRICES.

Comparative Prices of 108 Staple Articles. Raw and Manufactured Products, Produce, Cattle and Meats, at Quarterly and Monthly Intervals, Showing Fluctuations in Quotations from July 1, 1892 to May 1, 1897, Covering the Period of Recent Extreme Depression. Tabulated statement. 2500 w. Bradstreet's—May 22, 1897. No. 13045. 15 cts.

TARIFF.

Dutiable and Free Lists of the New Canadian Tariff. The list as formally announced April 23, and that went into effect immediately. 2000 w. Bul of Am Ir & St Inst—May 10, 1897. No. 12804. 15 cts.

Tariff Changes and Customs Regulations. Belgium, France, French Guiana, Austria, Austria-Hungary, Roumania, Bulgaria, United States, United States of Colombia, Venezuela, Ecuador, Cyprus, Lagos, Cape of Good Hope. 5000 w. Bd of Trd Jour—May, 1897. No. 13130. 30 cts.

YANGTZE KIANG.

The Region of the Yangtze Kiang. A report aiming to give an accurate account of the trade of this region. A description of the river, and important ports is given and a very interesting account of the industries, trade, &c. 8500 w. Cons Repts—May, 1897. No. 13040. 45 cts.

CURRENCY AND FINANCE.

CHINA.

Silver in China, and Its Relation to Chinese Copper Coinage. Talcott Williams. Reviews the history of silver as a currency, and shows that the same laws control and operate in the working of currency in China as are felt elsewhere. 6800 w. An Am Acad—May, 1897. No. 12909. $1.00.

COINAGE.

Theory and History of Coinage. From the Annual Report of the Director of the Mint. A survey of the coinage in various countries, their values, and related information. 7500 w. Bankers Mag, N. Y.—May, 1897. Serial, 1st part. No. 12871. 45 cts.

FINANCE.

The Financial Relations Between Ireland and Great Britain. L. H. Courtney. A statement of the case and suggestions for securing justice. 6300 w. Contemporary Rev—May, 1897. No. 12872. 45 cts.

JAPAN.

Japanese Currency and Industry. Editorial on the recent legislation in regard to the currency and information given in report of Mr. Jamieson, the Consul in Shanghai. 1800 w. Engng—May 21, 1897. No. 13153. 30 cts.

GOVERNMENT CONTROL.

COMMERCE.

Congress Should Regulate All Our Commerce. Howard S. Abbott. Condensed paper read at National Convention of RR. Commissioners, at St. Louis. 1900 w. RR Gaz—May 21, 1897. No. 12984 15 cts.

DIFFERENTIALS.

The Outports in the Differential Rate Case.

Report of the Philadelphia meeting of the commission, which was mainly devoted to the exposition of views of shippers and grain dealers of that city and Baltimore. 1100 w. Bradstreet's—May 15, 1895. No. 12887. 15 cts.

FACTORY Acts.

India-Rubber Works and the Factory Acts. Explains why the order has been issued, and combatting the idea that india-rubber working generally is an unhealthy means of livelihood. 2200 w. Engng—May 7, 1897. No. 12902. 30 cts.

INTERSTATE Commerce.

The Latest Interstate Commerce Decisions. Editorial comment on the decision dealing with the question of the power of the commission to fix rates, and other decisions of the Supreme Court. 1300 w. Bradstreet's—May 29, 1897. No. 13186. 15 cts.

TRANS-MISSOURI.

The Trans-Missouri Decision. George R. Blanchard. Presents the public necessity for legalized railway compacts; argues that they do not and will not unreasonably restrain trade or commerce; and that their intent is an important feature of their creation, in practice if not in law. 3500 w. Forum—June, 1897. No. 13195. 30 cts.

LABOR.

ACCIDENTS.

Protection to Workingmen in Germany. (Die Wirkung der Deutschen Arbeiterversicherung.) Report of a standing committee of the Workingmen's Beneficial Society. Contains a special investigation of the dangers of acetylene and the reasonable precautions for its safe handling. Two articles. 3500 w. Gesundheits Ingenieur—April 30, May 15, 1897. No. 12780. 60 cts.

APPRENTICES.

The Trade School and the Apprentice Question. W. F. Taaffe. Explains the object of the trade school, and comments on the false ideas concerning it, advising that the period passed at a trade school be deducted from the apprenticeship term. 1400 w. San Plumb—May 1, 1897. No. 12636. 15 cts.

CAPITAL and Labor.

Large Aggregations of Capital. George Gunton. An article written for the N. Y. *Independent*. Showing that in every line of production where the aggregation of capital has increased for permanent productive purposes, the effect has been to improve the quality of the services rendered and reduce the price to the public. The effect in wages, permanent employment, &c., is considered. 2800 w. Gunton's Mag—May, 1897. No. 12608. 30 cts.

Another Step in Promoting the Union of Capital and Labor. George Livesey. The writer is opposed to workers' unions. discusses profit-sharing and various other matters. Discussion. Read before the Inst. of Gas Engs., London. 7500 w. Gas Wld—May 8, 1897. No. 12992. 30 cts.

COMPENSATION Bill.

The Workman's Compensation Bill. The essential clauses of this bill, introduced to the House of Commons by Sir Matthew Ridley, with brief comment. 1000 w. Eng, Lond—May 7, 1897. No. 12906. 30 cts.

EUROPEAN Labor Problems.

Economic and Social Problems in Europe. Discusses the subject matter of four books which have recently been published in England and France. Foundations of Success, by S. de Brath; the Struggle of the Nations, by Prof. Maspero; Made in Germany, by E. E. Williams, and Le Danger Allemand, by Maurice Schwab. 2500 w. Cons Reports—May, 1897. No. 13041. 45 cts.

NON-EMPLOYMENT.

Insurance Against Non-Employment. Paul Monroe. A private enterprise for insuring against non-employment began business with the current year in Chicago. The scheme is outlined and facts stated without passing judgment. 4400 w. Am Jour of Soc—May, 1897. No. 12839. 45 cts.

PROFIT Sharing.

Profit Sharing in England. Information obtained from Mr. George Livesey regarding the social experiment which has been successfully tried by the South Metropolitan Gas Company, of London. 4500 w. Cons Repts—May, 1897. No. 13042. 45 cts.

STRIKE.

The New Retort-House Rules at the Leeds Gas-Works. A statement of the trouble on account of dissatisfaction with the new code of rules. The men submit an alternative set. A strike resulted, but the men finally agree to try the new rules. 3800 w. Jour Gas Lgt—April 27, 1897. No. 12665. 30 cts.

The New Retort-House Rules at the Leeds Gas Works. Gives the results of the trial made of the committee's rules. 1100 w. Jour Gas Lgt—May 4, 1897. No. 12852. 30 cts.

Some Suggestions Concerning Strikes. Frank L. McVey. Some remarks on the dangerous and expensive character of strikes, the reason for their existence, the elements which make them difficult to deal with, and general suggestions. 2400 w. Eng's Year Book, Univ of Minnesota, 1897. No. 13000. 45 cts.

Trades Unionism and Strikes. Comments on the change of feeling apparent among trades unionists, very much more adverse to reckless adoption of extreme measures; reference is made to the attitude of the Amalgamated Society in England. 1700 w. Prac Eng—April 23, 1897. No. 12605. 30 cts.

TRUSTS.

The Trust and the Working-Man. Lloyd Bryce. Presents the difficulties in the way of legislating against these industrial agreements, and shows that so far from injuring the public, they have borne their share in benefitting it. 5000 w. N Am Rev—June, 1897. No. 13220. 45 cts.

WAGES.

Senator Elkins and American Wages. Comments on the attitude of Senator Elkins, and some of the leading journals, in declaring that wages must go down. 1300 w. Gunton's Mag—June, 1897. No. 13251. 30 cts.

Work and Wages of Men, Women and Children. The results shown in the Eleventh Annual Report of the Commissioner of Labor, covering

the employment and wages of women and children as compared with men in like occupations, how far women and children are superseding men, and the relative efficiency of men, women and children when employed in doing like work. 8000 w. Bul Dept of Labor—May, 1897. No. 12613. 45 cts.

MISCELLANY.

BOSTON.

The Port of Boston. Some facts concerning New England's metropolis, its harbor, exports and imports, &c. Ill. 1600 w. Sea—May 20, 1897. No. 12980. 15 cts.

EXPOSITION.

The Importance of the Universal Exposition of 1900. J. C. Charpentier. Forecasting the scope of the approaching Paris Exposition and the features that will distinguish it. 3200 w. Eng Mag—Juue, 1897. No. 13256. 30 cts.

The Paris Exposition of 1900. (Die Pariser Weltausstellung im Jahre 1900.) The first of a series of articles by Herr Bömehes, to be continued as the work progresses. This instalment contains comparative accounts of the previous Paris Expositions. 2500 w. Zeitschr d Oester Ing u Arch Ver—April 2, 1897. No. 12716. 30 cts.

Paris Exposition of 1900. (Exposition de 1900). Miscellaneous notes concerning the progress of the work, with full-page bird's-eye view of the grounds and buildings. 2000 w. Le Génie Moderne—May 1, 1897. No. 12741. 30 cts.

ELECTRICAL ENGINEERING.

ELECTRO-CHEMISTRY.

ALLOYS.

Improvements in the Electrolytic Separation of Metallic Alloys. (Neuerungen in der Herstellung von Metall-Legierungen auf Elektrolytischem Wege.) Indicating a number of possible technical operations of electrolytic separation including also combinations of metals and metalloids. 2500 w. Zeitschr für Elektrochemie—March 5, 1897. No. 12451. 15 cts.

CARBON.

The Electrochemical Equivalent of Carbon. (Das Elektrochemische Aequivalent des Kohlenstoffs.) A number of experimental determinations give values closely approximating that due to theory. 1000 w. Zeitschr f Elektrochemie —April 5, 1897. No. 12770. 30 cts.

DECOMPOSITION.

Electrolytic Apparatus for Decomposition of Salt Solutions. (Elektrolytischer Apparat zur Zerselzung von Salzlösungen.) A description by Dr. Koch of his improved apparatus, using a quicksilver cathode. 2000 w. Elektrochemische Zeitschr—May, 1897. No. 12767. 30 cts.

The Chemical Decomposition of Sulphur. (Ueber die Chemische Zerlegbarkeit des Schwefels.) A paper by Theodor Gross, in which he describes an electro-chemical decomposition of sulphur and the isolation of a new element called Bythium. 5000 w. Elektrochemische Zeitschr—April, 1897. No. 12764. 30 cts.

ELECTROLYSIS.

Laboratory Apparatus for Electrolysis. (Laboratoriums-Apparat für Electrolyse.) Describes various forms in which the electrolyte may be at rest or circulating; enabling a variety of electrochemical reactions to be observed. 2000 w. Zeitschr f Elektrochemie—April 20, 1897. No. 12772. 30 cts.

Report upon Work with Electrolysis. (Bericht über die Arbeit mit Elektrolyse.) An account of the commercial results of electrolysis in the Stepanowka sugar refinery and the chemical and mechanical economies obtained. 6000 w. Elektrochemische Zeitschr—April, 1897. No. 12765. 30 cts.

The Extraction of Metals from Their Ores by Means of Electrolysis. Extracts from a report by C. Schnabel in the Chemiker Zeitung. This particular report refers to the non-ferrous metals, and deals with zinc, gold, silver, nickel, copper and aluminum. 1400 w. Elec Rev, Lond—April 23, 1897. No. 12595. 30 cts.

See also Street and Electric Railways.

POTASSIUM Percarbonate.

The Production and Properties of Potassuim Percarbonate. (Ueber die Darstellung und die Eigenschaften des Kalium-Percarbonats.) An account by Prof. Hansen, of the electrolytic production of percarbonate of potassium, in the laboratory of the Zurich Polytechnic. 3000 w. Zeitschr f Elektrochemie—April 20, 1897. No. 12771. 30 cts.

LIGHTING.

ARC LIGHTING.

Arc Lighting in America and Europe. C. Wiler. Abstract of paper read before the Chicago Elec. Assn. Showing the conditions under which arc lighting developed in Europe and America, and the results as a consequence of these varying conditions. 2800 w. Elec Eng —May 5, 1897. No. 12628. 15 cts.

ARTIFICIAL Light.

Artificial Light: Modern Methods Compared —Electric-Incandescent, Welsbach, Acetylene. D. S. Jacobus. A lecture introduced by experiments in colors, discussing candle-power developed per cubic foot of gas, electrical energy to produce the electric light, relative heating and contamination of atmosphere, explosive properties of acetylene, &c. 3600 w. Jour Fr Inst—May, 1897. No. 12646. 45 cts.

BLOOMHILL, Eng.

The Bloomhill Electrical Installation. David Salomons. A brief outline of the history of the plant and a general survey, with illustrations. Describes the installation and laboratories. 4000 w. Am Elect'n—May, 1897. No. 12865. 15 cts.

COATBRIDGE.

Coatbridge: Old and New. Illustrations of the remodelled station, where a gas plant has been abandoned in favor of steam engines, with a study of the causes that led to failure. 3300

w. Elect'n—May 7, 1897. No. 12925. 30 cts.

FILAMENTS.

High-Voltage Lamp Filaments. Alfred H. Gibbings. Deals with double- and single-filament lamps, preferring the latter. Ill. 1000 w. Elec, Lond—April 30, 1897. No. 12696. 30 cts.

GAS Engines.

Electric Lighting by Gas Engines. F. W. Richart. Discusses the problem of choosing an engine, the methods of governing, efficiency, faults, and general operation. 2800 w. Technograph. No. XI. No. 13034. 45 cts.

HARROW.

Harrow Electricity Works. Illustrated detailed description. 3300 w. Elec Eng, Lond—May 14, 1897. No. 13099. 30 cts.

HOSPITAL Lighting.

The Construction, Installation, and Performance of the Electric-Lighting Plant at the Government Hospital for the Insane at Washington, D. C. G. W. Baird. Description and data of performance. 4400 w. Jour of Am Soc of Nav Engs—May, 1897. No. 12910. $1.25.

ILLUMINATION.

Experimental Researches in the Efficiency of Lighting. (Versuche mit Verchiedenen Beleuchtungsarten.) Tabulated results of comparative tests for lighting of schools. The results are for arc and incandescent electric lamps, and for ordinary, Siemens, and Welsbach gas lamps. 1500 w. Zeitsch d Oesterr Ing u Arch Ver—May 7, 1897. No. 12727. 30 cts.

The Production and Utilization of Light Waves. (Ueber Entstehung und Ausnützung von Lichtwellen.) An investigation of the illuminating efficiency and cost of various modes of artificial lighting, including the heating and color effects. 1500 w. Gesundheits Ingenieur. April 30, 1897. No. 12779. 30 cts.

See also "Lighting," below.

INCANDESCENT Lamp.

Glowing of Disconnected Incandescent Lamps. N. S. Amstutz. Unpublished data with reference to experiment previously published. Ill. 1100 w. Elec—May 12, 1897. No. 12861. 15 cts.

Incandescent-Lamp Efficiency: Its Importance to Central Stations. H. L Monroe. Read before Texas Gas and Electric Light Assn. Considers the light producing efficiency, lamp renewals, economy, &c. Discussion follows. 6300 w. Am Gas Lgt Jour—May 17, 1897. No. 12926. 15 cts.

INTERIOR Wiring.

Tubing for Interior Electric-Lighting Wires. Charles Henry Davis and Howard C. Forbes. The subject is considered from the commercial and from the engineering standpoint. Ill. 2000 w. Elec Rev—May 19, 1897. No. 12938. 15 cts.

Uninsulated Pipe for Interior Wiring. V. Zingler. The object of the paper is to compare the uninsulated pipe with the insulated, from a practical point of view, and in the latter part of the article hints for its efficient installation will be given, taken from the result of actual experience. 2500 w. Elec Rev, Lond—May 7, 1897. Serial. 1st part. No. 12920. 30 cts.

LIGHTING.

Electric Lighting. H. H. Norris. Illustrated description of the incandescent lamp and the arc lamp. 3300 w. Sib Jour of Engng—May, 1897. No. 12963. 30 cts.

See also "Illumination," above.

OPTICAL Lantern.

The Electric Light in the Optical Lantern. Cecil M. Hepworth. A consideration of points necessary to get the greatest amount of light and send it in the right direction. 2000 w. Sci Am Sup—May 15, 1897. No. 12858. 15 cts.

PARIS.

Lighting Station of the Champs-Elysées at Levallois. (Usine de la Compagnie d'Éclairage Électrique du Lecteur des Champs-Élysées a Levallois.) Illustrated description of one of the largest stations in Paris. The alternating generators are built up on the fly wheels of the large Corliss engines. 3000 w. 1 plate. La Revue Technique—April 25, 1897. No. 12734. 45 cts.

STATION Enlargement.

Enlargement of One of the Central Stations of the Municipal Electric-Light Company, Brooklyn, New York. Illustrated description and data of the Rodney street station, which contains some of the latest improvements in electrical engineering. 1800 w. Elec Wld—May 29, 1897. No. 13212. 15 cts.

STATIONS.

Small Electric Stations by the Esslingen Machine Works. (Einige Kleinere Elektrizitätswerke der Maschinen Fabrik Esslingen.) Describing and illustrating several well-arranged lighting and power plants of moderate size. 5000 w. Zeitschr d Ver Deutscher Ing—May 15, 1897. No. 12713. 30 cts.

STREET Lighting.

See Municipal Engineering, Streets and Pavements.

THEATRE.

The New Empire Palace, Glasgow. Brief description devoted mostly to the electrical installation. Ill. 1000 w. Elec Eng, Lond—April 23, 1897. No. 12600. 30 cts.

VACUUM Tubes.

Some Researches with Vacuum Tubes. (Einige Versuche mit Vakuumröhren.) Investigating the fluorescent action, and discussing the researches of Korda, Oudin and Colardeau. 2000 w. Elektrotechnische Zeitschr—May 6, 1897. No. 12763. 30 cts.

Vacuum-Tube Lighting. An account of a private seance given by D. McFarlan Moore at his laboratory, to a number of invited guests, to demonstrate the progress made in vacuum-tube lighting. Also editorial. 1200 w. Elec—June 2, 1897. No. 13242. 15 cts.

POWER.

ACCUMULATORS.

See same title under Street and Electric Railways.

ALTERNATOR.

A Novel Three-Phase Alternator. Geo. D. Shepardson. Illustrated description. 1100 w. Eng's Year Book, Univ of Minn—1897. No. 13003. 45 cts.

ARMATURES.

Armature Reaction and the Theory of Commutation. C. C. Hawkins. Part first considers the reaction of a single inductor, the steady E. M. F. of a single inductor unaffected, and self-excitation with separate magnet winding. 1700 w. Elect'n—April 30, 1897. Serial. 1st part. No. 12813. 30 cts.

Heating of Armatures. George Moffat. Treats of the cause of undue heating and the requisites for cool running. 1200 w. Elec Eng—May 26, 1897. No. 13118. 15 cts.

CHARGES.

The Tariff for Supply of Current from Electric Stations. (Die Stromtarife bei Elektricitätswerken.) A paper before the German Electrotechnic Society discussing the rate of charges for current for light and power in the various cities of Germany, with curves showing the relations. 7500 w. Elektrotechnische Zeitschr—April 22, 1897. No. 12761. 30 cts.

CURVES.

Curve Construction. (Ueber Kurvenaufnahmen.) Describing Joubert's method of plotting the curves of alternating currents. 2000 w. Elektrotechnische Zeitschr—April 15, 1897. No. 12757. 30 cts.

DYNAMO.

A Multifunctional Dynamo. George D. Shepardson. Describes the Edison dynamo of the Univ. of Minn. as an example of the value and flexibility of electrical machinery. 1500 w. Eng's Year Book, Univ of Minn—1897. No. 13008. 45 cts.

Dynamo Characteristics. Wilbur M. Stine. Considers the effect of armature reaction, and the causes for the departure of actual curves from their theoretical outlines. 1100 w. Am Elect'n—May, 1897. No. 12866. 15 cts.

ELECTRIC Plant.

See same title under Street and Electric Railways.

ELEVATORS.

The Performance of the Sprague Electric Elevators in the Minneapolis City Hall and County Court House. Frank J. Sprague. Full report of the committee employed by the commissioners to test the machines. 1500 w. Elec Eng—May 12, 1897. No. 12854. 15 cts.

Practical Construction of Rheostats for Electric Elevators. F. M. Everett. Considers the requirements and the existing conditions under which the rheostat is to operate, with drawings illustrating types used upon modern electric-elevator engines. 1400 w. Technograph—No. XI. No. 13029. 45 cts.

FACTORIES.

Transmission of Power in Factories by Electricity. S. V. Clirehugh. Read before the Northern Society of Electrical Engs. Points in connection with power distribution, especially in factories devoted to the textile trades. 4000 w. Ind & Ir—May 21, 1897. No. 13216. 30 cts.

Electrical Power-Equipment for General Factory Purposes. Dugald C. Jackson. A summary of the more recent results, and a résumé of the views held in a number of the great manufacturing establishments where experience has been had with electrical transmission and distribution of power. 4500 w. Trans Am Soc of Mech Engs—Vol. XVIII. May, 1897. No. 13049. 45 cts.

GENERATORS.

Theory of the Three Wire Generator with Double Field System. (Theorie der Dreileitermaschinen nach dem Doppelfeldsystem.) An historical review of the subject by Herr Rothert, with an account of his own improved construction. Two articles, 6000 w. Electrotechnische Zeitschr—April 23 and 29, 1897. No. 12759. 60 cts.

MACHINE Shop.

See title "Electricity" under Mechanical Engineering, Shop and Foundry.

MANUFACTURING Plants.

The Equipment of Manufacturing Establishments with Electric Motors and Electric-Power Distribution. Leland L. Summers. Conclusions from results obtained in fourteen different establishments, as given in Prof. Jackson's paper before the W Soc of Engs. 800 w. Elec Engng—May 15, 1897. No. 12874. 15 cts.

MARINE Engineering.

Electrical Transmission of Power. F. Von Kodolitsch. Read before the Inst. of Naval Arch'ts. Application of electrical transmission of power in marine engineering and ship building. 3500 w. Engng—April 30, 1897. No. 12687. 30 cts.

MOTOR.

Rotary Current Motors with Variable Number of Poles. (Drehstrommotoren mit Variabler Polzahl.) The phases can be divided into groups by a peculiar system of connections, practically corresponding to a change of winding. 1500 w. Electrotechnische Zeitschr—May 6, 1897. No. 12762. 30 cts.

See also "Electric Motor" under Mechanical Engineering, Engines and Motors.

POWER Plant.

The Power Plant, Pipe Line and Dam of the Pioneer Electric-Power Company of Ogden, Utah. Henry Goldmark. Describes in detail these works recently built in the cañon of the Ogden River, which constitute the most important hydraulic-power plant of Utah, and one of the largest works of the kind in the country. 20500 w. Pro Am Soc of Civ Engs—May, 1897. No. 13127. 75 cts.

PUMPING.

Electric Pumping. A. T. Maltby. Electric power as available for pumping is considered under three heads, based on the nature of the generating power, with illustrations of various plants. An account of the present stage of advancement of this branch of electrical application. 1700 w. Am Elect'n—May, 1897. No. 12868. 15 cts.

RATING.

On Rating Electric-Power Plants upon the Heat-Unit Standard. William S. Aldrich. States the advantages of having such a standard for this purpose founded upon the heat-unit basis, and discusses the various phases of the subject. 4200 w. Trans Am Soc of Mech Engs—Vol. XVIII. May, 1897. No. 13061. 45 cts.

SAFETY Device.

See Street and Electric Railways.

ST. ANTHONY Falls.

The St. Anthony Falls Electric-Transmission

Plant. Illustrated description of the plant that operates all the street railways of Minneapolis and St. Paul. 2000 w. St Ry Jour—June, 1897. No. 13193. 45 cts.

TRANSFORMER.

The Alternate-Current Transformer. The first of a series of articles on the construction and design of alternate-current transformers, and the part played by them in the distribution of electricity. 1500 w. Elec, Lond—May 21, 1897. Serial. 1st part. No. 13200. 30 cts.

Direct-Current Transformer. C. Thordarson. Read before the Chicago Elec. Assn. Presents the advantages of the direct continuous current as a method for transmitting electrical energy, and discusses the objections to the direct-current transformer. 1500 w. W Elect'n—May 29, 1897. No. 13144. 15 cts.

TRANSMISSION.

Long-Distance Transmission at Bakersfield, Cal. Illustrated description of plant for utilizing the power of Kern river. 800 w. St Ry Rev—May 15, 1897. No. 12952. 30 cts.

Power Transmission by Three-Phase and Continuous Currents. G. L. Addenbrooke. A presentation of the changed conditions and the points to be considered in any argument of a continuous versus a three-phase power transmission. 2000 w. Elec Rev, Lond—April 30, 1897. No. 12819. 30 cts.

The Bellegarde Electric-Power Transmission. C. S. Du Riche Preller. Illustrated description of the utilization of the water power of the Rhone at Bellegarde, 20 miles below Geneva. 2000 w. Engng—May 14, 1897. Serial. 1st part. No. 13075. 30 cts.

The St. Lawrence Power-Transmission Scheme. Brief description of the project to utilize the waters of the St. Lawrence in the neighborhood of the township of Massena. 1800 w. Elec Eng, Lond—May 21, 1897. No. 13215. 30 cts.

TURNTABLE.

See Railroad Affairs, Terminals and Yards.

TELEGRAPHY AND TELEPHONY.

BERLINER Patent.

Decision in Favor of American Bell Telephone Company Sustaining Legality of the Issuance of the Berliner Patent. Brief statement of the case with conclusions. 2000 w. Elec Eng—May 12, 1897. No. 12855. 15 cts.

Has the Berliner Patent Expired? In the opinion of Geo. H. Benjamin, an eminent patent attorney, it expired in 1894, through the expiration of a prior English patent to Berliner. 500 w. Elec Rev—May 26, 1897. No. 13109. 15 cts.

The Effect of the Berliner Decision. A summary of opinions from various telephone companies and telephone men. 3000 w. Elec Wld—May 15, 1897. No. 12943. 15 cts.

The Full Text of the Opinion in the Berliner Case. 13800 w. Elec Wld—May 22, 1897. No. 13095. 15 cts.

The History of the Berliner Patent. The complete history of the patent is briefly given. Ill. 1200 w. Elec Wld—May 15, 1897. No. 12942. 15 cts.

CABLE LAYING.

Rapid Cable-Laying for War Purposes. Lieut. Crutchley and C. Scott Snell. Describes an apparatus which it is claimed can safely lay a submarine cable at any rate of speed within the compass of the fastest cruiser, and sketches a plan showing how this might be of value in war-time. Ill. 2400 w. Elec Rev, Lond—May 14, 1897. Serial. 1st part. No. 13087. 30 cts.

CABLES.

Disturbance of Submarine Cable Working by Electric Tramways. A. P. Trotter. Paper read before the Inst. of Elec Engs. An account of troubles at Cape Town, caused by the electric tramway service, and the experiments made to remedy the trouble. 4000 w. Elect'n—May 14, 1897. No. 13093. 30 cts.

Ocean Depths. Difficulties to be met in laying the Pacific cable are reviewed, and statements appearing in other papers criticized. 1700 w. Elec Rev, Lond—April 30, 1897. No. 12820. 30 cts.

Sullivan's Method of Determining the Relative Positions and the Top and Bottom Ends of Several Cables in a Tank. Alex. Taylor describes the method of H. W. Sullivan, treating the two tests separately. The relative positions are determined by the strength of the current induced in each one, and the order of their ends by the direction of this current. 2000 w. Elect'n—May 14, 1897. No. 13092. 30 cts.

The Drying of Air-space Cables. (Das Austrocknen von Luftraumkabeln.) Describes apparatus for removing the moisture from air insulated cables by chemical means, as used in Paris. 3000 w. Elektrotechnische Zeitschr—April 8, 1897. No. 12754. 30 cts.

ELECTRICAL Testing.

Electrical Testing for Telegraph Engineers. J. Elton Young. Extracted from a forthcoming work to be published by the Electrician Co. The theory and practice of testing as applied to all electrical lines is reviewed. 2000 w. Elect'n—April 30, 1897. Serial. 1st part. No. 12812. 30 cts.

REPEATER.

The Telephone Repeater. F. Jarvis Patten. Describes and illustrates a few of the types, showing how difficult it is to determine from a sketch what will work and what will not. The writer has never found a repeater that worked satisfactorily. Ill. 1800 w. Elec Wld—May 22, 1897. No. 13094. 15 cts.

SYNCHRONOGRAPH.

The Synchronograph—A New Method of Rapidly Transmitting Intelligence by the Alternating Current Albert C. Crehore and George O. Squier. Experiments upon a new electrical system of rapid intelligence-transmission and its possibilities. Ill. 12500 w. Trans Am Inst of Elec Engs—April, 1897. No. 13046. 45 cts.

TELEGRAPH.

Telegraphing without Wires. (La Télégraphie sans Fil.) A review of the experiments of Preece, Steinheil and others. 2500 w. La Revue Technique—April 10, 1897. No. 12731. 45 cts.

The Railway Telegraph. G. C. Kinsman. History of the inception of the telegraph, and of its application to train movements. Reminiscences of De Wilmot Smith. 3000 w. Ry Mag—April, 1897. No. 12836. 30 cts.

The Support of Telegraph Wires of Iron and Bronze. (Durchhang von Telegraphendrähten aus Eisen und Bronce.) A discussion of the strains upon telegraph wires for various temperatures and distances between poles. 2500 w. Elektrotechnische Zeitschr—March 11, 1897. No. 12460. 30 cts.

TELEPHONE Plant.

The Cost of Constructing, Operating and Maintaining a Telephone Plant for 2,600 Subscribers. Investigations of a committee showing investment and cost of operation and maintenance, with detailed statement of cost of repairs, &c. 1400 w. Elec Engng—May 15, 1897. No. 12875. 15 cts.

TELEPHONES.

Microphonic Telephonic Action. R. A. Fessenden. An article expressing disagreement with Dr. Berliner's theory. 2400 w. Am Elect'n—May, 1897. No. 12869. 15 cts.

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BALANCE.

Investigations with the du Bois Magnetic Balance. (Untersuchungen über die du Bois'sche Magnetische Waage.) By means of the du Bois balance the magnetic properties of various irons or steels may be precisely investigated, and graphical curves constructed from the results. 3500 w. Elektrotechnische Zeitschr—April 8, 1897. No. 12755. 30 cts.

CARBON.

The Electrical Action of Carbon in Flames. Richard P. Fuge. Experiments are described, showing the effect of using carbon in one or other of its various forms instead of a metal in the flame. 1800 w. Elec Rev, Lond—May 7, 1897. No. 12921. 30 cts.

CATHODE Rays.

Cathode Rays. J. J. Thomson. Discourse delivered at the Royal Inst. An account of some of the more recent investigations. Ill. 5500 w. Elec'n—May 21, 1897. No. 13213. 30 cts.

See also "Roentgen" and "X Rays."

CONDUCTORS.

Behavior of Discontinuous Conductors Subjected to Electrical Actions. G. Vicentini. A report of investigations, giving experiments on large masses of emulsion, experiments with small masses, and experiments under simple conditions. 1500 w. Elect'n—April 23, 1897. No. 12603. 30 cts.

CURRENTS.

A Rapid Break for Large Currents. A. G. Webster. A description of the apparatus and a test are given. Ill. 1200 w. Am Jour of Sci—May, 1897. No. 12610. 45 cts.

The Effect of Great Current-Strength on the Conductivity of Electrolytes. Theodore William Richards and John Trowbridge. Investigations to determine if the intense current involved in the discharge of a large condenser is capable of causing any change in the condition of an electrolyte. Concludes that it is not essentially affected. 700 w. Am Jour of Sci—May, 1897. No. 12612. 45 cts.

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The Direct Conversion of Heat into Electricity. Harry Barringer Cox. Abstract of a lecture delivered before the N. Y. Elec. Soc. Describes his work in this field. Discussion follows. 3000 w. Elec Eng—June 2, 1897. No. 13243. 15 cts.

ELECTRICAL History.

Epoch-Making Events in Electricity. G. H. Stockbridge. Arago's experiments and the beginnings of magneto-electricity. 3300 w. Eng Mag—June, 1897. Serial. 3d part. No. 13263. 30 cts.

ELECTRIC Energy.

On the Conversion of Electric Energy in Dielectrics. Richard Threlfall. An account of the writer's experiments, preceded by a brief review of the work of others in the same field. 8000 w. Phys Rev—May-June, 1897. Serial. 1st part. No. 12932. 45 cts.

ETHER.

The Electrical Conductivity of the Ether. John Trowbridge. Outlines a method which enables one to form an estimate of the energy incident upon the production of the Röntgen rays. The experiments made lead to the conclusion that under very high electrical stress the ether becomes a good conductor. 1700 w. Am Jour of Sci—May, 1897. No. 12611. 45 cts.

GALVANOMETER.

Principles and Efficiency of the Mirror Galvanometer. (Konstruktionsgrundsätze und Leistungsfähigkeit Unserer Spiegelgalvanometer.) An elaborate investigation of improved galvanometers especially for the measurement of very weak currents. Serial. 1st part. 2500 w. Zeitschr f Elektrochemie—April 5, 1897. No. 12768. 30 cts.

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Electro-Germination. Asa S. Kinney. Illustrated description of apparatus and methods. 1300 w. Sci Am Sup—May 15, 1897. Serial. 1st part. No. 12859. 15 cts.

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Faults in Measuring Instruments. Considers the faults of the voltmeter, the ammeter, the recording wattmeter, and recording ammeter. 2500 w. Am Elect'n—May, 1897. No. 12870. 15 cts.

IRON Cores.

Magnetic Distribution in Short Iron Cores. W. G. Campbell. Results of experiments made for the solution of the questions, What percentage of the total lines of induction produced at the middle of the primary core, passes through the windings of the secondary coil; and what magnetizing force is necessary to produce the required induction in the core. 1800 w. Technograph—No. XI. No. 13036. 45 cts.

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The Arrangement of Lightning Conductors. (Ueber die Anlage von Blitzableitern.) Giving precautions as to connections and grounding, together with proportions of surface protected by given arrangements. 2000 w. Elecktrotechnische Zeitschr—April 22, 1897. No. 12760. 30 cts.

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A New Action of Magnetism upon Light. (Ueber eine Neue Wirkung des Magnetismus auf

das Licht.) An account of Dr. Zeeman's experiments showing the action of magnetism upon both the emission and absorption spectra. 1500 w. Elektrotechnische Zeitscher—April 15, 1897. No. 12758. 30 cts.

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Useful Conceptions about Magnetic Phenomena. (Hülfsvorstellungen bei Magnetischen Erscheinungen.) A discussion of the phenomena of hysterisis, remanence, permeability, &c., from the metallurgists standpoint, and their relation to various kinds of material. 6000 w. Stahl und Eisen—April 15, 1897. No. 12781. 45 cts.

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The most Advantageous Spacing of Poles for Supporting Wires. (Ueber die Bestimmung der Günstigen Mastenintervalle bei Fernleitungen.) Discusses the question of the best economy of poles with the proper stresses upon the wires to be supported. 1500 w. Elektrotechnische Zeitschr—April 8, 1897. No. 12753. 30 cts.

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See Municipal Engineering, Miscellany.

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The Internal Resistance of Galvanic Cells. (Ueber den Innern Widerstand Galvanischer Zellen.) Especially relating to the resistance of various forms of accumulator cells. 2500 w. Zeitschr f Elektrochemie—April 5, 1897. No. 12769. 30 cts..

Virtual Resistance, Irving A. Taylor. Considerations which lead to the conclusion that, in general, the virtual increase of resistance occurring in a conductor traversed by alternating currents is so slight that, when the other more important phenomena occurring in conjunction with it are considered, it may be safely left out of practical calculations. 4500 w. Elec Engng—May 15, 1897. No. 12873. 15 cts.

RIGIDITY.

The Magnetic Increment of Rigidity in Strong Fields. Howard D. Day. Treats of the increase of resistance to torque, produced by magnetization of twisted wires of various diameters, when the magnetic field increases to many times the amount needed to bring out the ordinary magnetic saturation. 2500 w. Am Jour of Sci—June, 1897. No. 13217. 45 cts.

ROENTGEN Rays.

On the Electrification of Gases Exposed to Röntgen Rays, and the Absorption of Röntgen Radiation by Gases and Vapors. E. Rutherford. Experiments which have been made to investigate the way in which electrified gases can be obtained by means of the Röntgen rays, and also to examine the properties of the charged gas. 4500 w. Elect'n—April 23, 1897. No. 12604. 30 cts.

ROENTGEN Tubes.

Tesla on the Hurtful Actions of Lenard and Röntgen Tubes. Gives the writer's experience with the Röntgen rays, relating chiefly to their deleterious action on human tissues. 4000 w. Elec Rev—May 5, 1897. No. 12632. 15 cts.

X-RAYS.

Adjustable X-Ray Focus Tubes. A. A. C. Swinton. Describes and illustrates two forms of adjustable focus tubes. 1200 w. Elec Wld—May 8, 1897. No. 12807. 15 cts.

The Effect of the Density of the Surrounding Gas on the Discharge of Electrified Metals by X-Rays. C. D. Child. Experimental work with brief account of results. 2000 w. Science—May 21, 1897. No. 13024. 15 cts.

The Harmful Effects of the X-Ray. F. S. Kolle. Discusses ideas advanced by Tesla, and gives the writer's experience and opinions. 1200 w. Elec Eng—May 19, 1897. No. 12936. 15 cts.

See also "Cathode" and "Röntgen."

URANIUM.

Continuation of Experiments on Electric Properties of Uranium. Lord Kelvin, J. Carruthers Beattie, and M. S. de Smolan. Read before the Royal Soc of Edinburgh. Results bearing on the conductance induced in air by uranium. 1000 w. Nature—May 6, 1897. No. 12923. 30 cts.

VIBRATIONS.

The Absorption and Emission of Electric Vibrations. (Ueber die Absorption und Emission der Elektrischen Schwingungen.) A theoretical discussion of the relations of electric to other physical vibrations. 2000 w. Die Elektrizität—April 24, 1897. No. 12774. 30 cts.

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BOILERS AND ENGINES.

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The Accident to H. M. S. "Star." Editorial on the accident to the torpedo-boat destroyer, caused by a split cylinder. 1400 w. Engng—May 7, 1897. No. 12901. 30 cts.

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New Scotch Boilers for U. S. S. Chicago. Illustration and brief description of one of the four Scotch boilers. It is the first nickel-steel boiler built in the United States. 1200 w. Marine Engng—May, 1897. No. 12698. 30 cts.

CONTRACT Trials.

The Contract Trials of the U. S. Gunboats Helena and Wilmington. W. S. Smith. Detailed descriptions with account of trials, giving data. Ill. 4000 w. Jour Am Soc of Nav Engs—May, 1897. No. 12914. $1.25.

Contract Trial of the Gresham. C. A. Mc-

Allister. Describes this single-screw steel revenue cutter, built by the Globe Iron-Works Co. of Cleveland, O., giving dimensions, ratios, &c., of the engine, and account of trial trip with data. Ill. 3500 w. Jour Am Soc of Nav Engs—May, 1897. No. 12911. $1.25.

The Official Trial Trip of the U. S. Gunboat "Annapolis." This is the first U. S. government vessel of large size to be fitted with boilers of the water-tube type exclusively. Description and dimensions, with brief report of trial. 500 w. Eng News—May 13, 1897. No. 12878. 15 cts.

DOCKS.

The Position and Prospects of the Milford Docks. A brief history of the undertaking, with the story of the difficulties. Interesting to those concerned in port administration. 3300 w. Trans—May 14, 1897. No. 13097. 30 cts.

DRY-DOCK.

A Leak in the New Dry-Dock, Brooklyn Navy Yard. A statement of the case based on such facts as could be ascertained, with the measures being taken to remedy the defect. 1000 w. Sci Am—May 22, 1897. No. 12966. 15 cts.

ENGINES.

Inglis's Triple-Expansion Paddle-Wheel Engines. Illustrated description of the engines for the paddle-steamer Paris, built for the River Plate Co. 1500 w. Engng—April 30, 1897. No. 12683. 30 cts.

Marine-Engine Designs. William Burlingham. Aims to call attention to facts that ought to be observed in the design of marine engines, especially such as engineering works rarely discuss. 3000 w. Mach, N. Y.— June, 1897. Serial. 1st part. No. 13225. 15 cts.

HIGH Pressures.

High Pressures for Marine Engines. W. R. Cummins. Read before the North-East Coast Inst. of Engs & Shipbuilders. The writer recapitulates the arguments of a former paper as to the economy to be expected from increase of pressure, and touches upon the commercial aspect of the question; considers the type of boiler that will best suit the new conditions, and makes some suggestions as to the design of an engine most suitable for this increased pressure. 2500 w. Prac Eng—April 30, 1897. Serial. 1st part. No. 12815. 30 cts.

MOTOR.

The New Marine Motor. Describes a trip in the Turbinia, which made thirty-eight miles an hour at sea. Ill. 2200 w. Prac Eng—April 30, 1897. No. 12817. 30 cts.

PROPULSION.

The Application of the Compound Steam Turbine to the Purpose of Marine Propulson. Charles Parsons. Describes the Turbinia, with a summary of advantages claimed. Trials and abstract of discussion. 3800 w. Jour Am Soc of Nav Engs—May, 1897. No. 12915. $1.25.

SCOW.

Steam Dumping Scow for the Street Cleaning Department of New York. Illustrated description of scow, with brief comment on the efficient work of this department. 1300 w. Sci Am—June 5, 1897. No. 13250. 15 cts.

SHIPBUILDING.

A Useful Wood for Shipbuilding and Docks. An account of tests made on wood treated by a new method to protect it from all danger of combustion. 1000 w. Trans—May 14, 1897. No. 13098. 30 cts.

Shipbuilding, Ancient and Modern. M. W. Aisbitt. Abstract of paper read at meeting of the Bristol Channel Center of the Inst. of Marine Engs. Considers the proportions of the Ark, other ancient vessels, modern wooden vessels, advent of iron and steel, a steamer's requirements. 2500 w. Steamship—May, 1897. No. 12805. 30 cts.

SHIP-YARDS.

The Military Value of the Ship-Yard. Lewis Nixon. Résumé of the history of the U. S. naval reconstruction and survey of the existing situation, with comparison or constrast with the policy of Great Britain. 6000 w. N Amer Rev.—June, 1897. No. 13218. 45 cts.

STABILITY.

Hints on Elementary Stability, with Remarks on Water Ballast. A. S. Thomson. Read before the Shipmaster's Society, London. A study of the relation of the center of buoyancy to the center of gravity. 1800 w. Marine Engng—May 1897. No. 12697. 30 cts.

STEAMSHIPS.

Notes on the Estimation of the Power of Steamships at Sea and of Feed and Circulating Water at Sea. Nisbet Sinclair. Read before the Inst. of Engs. & Shipbuilders in Scotland. Part first discusses sea power and shows the importance of providing proper instruments and being able to furnish data of performances. Also begins the discussion of feed- and circulating-water. 2500 w. Ind & Ir—April 30, 1897. Serial. 1st part. No. 12693. 30 cts.

The Steamship La Grande Duchesse. Illustrated description of a new steamer recently built by the Newport News Shipbuilding and Dry-Dock Company. 1200 w. Eng, Lond—May 21, 1897. No. 13210. 30 cts.

TORPEDO Boat.

The Torpedo Boat Porter. Brief illustrated description. 600 w. Sci Am—May 22, 1897. No. 12967. 15 cts.

MECHANICAL ENGINEERING.

BOILERS, FURNACES AND FIRING.

BOILER Practice.

European Boiler Practice, R. S. Hale. Discusses types of boilers, economizers, superheaters, grates, mechanical stokers, boiler fittings, pipe coverings, chimneys, boiler operation, testing, labor in boiler room, steam engines &c. Discussion follows. Ill. 8000 w. Jour Assn of Enging Soc—April, 1897. No. 13016. 30 cts.

BOILER Prices.

Current Boiler Prices for Large Electrical Plants. An account of the bids for boilers re-

ceived by the United States Electric Lighting Co., of Washington, D. C. 600 w. Elec Eng —May 26, 1897. No. 13117. 15 cts.

BOILERS.

Boilers and the Use of Steam. William H. Bryan. A lecture delivered before the Wage Earners Self-Culture Club, St. Louis. Discusses what steam is, principal uses, types of boilers and of engines, efficiency of boilers and engines. 4000 w. Age of St—May 8, 1897. No. 12834. 15 cts.

BOILER Test.

Evaporation Test of a Boiler with Eccentric Internal Furnace Flue. (Verdampfungsversuche an einem Kessel mit Seitlichem Wellrohre.) A boiler of the Lancashire type, with corrugated furnace flue eccentrically placed. An evaporation of 9.98 lbs of water, and an efficiency of 75.5 per cent. was obtained. 1500 w. Zeitschr d Ver deutscher Ing—May 15, 1897. No. 12714. 30 cts.

Fuel-Gas Analyses in Boiler Tests. R. S. Hale. Describes a few of the devices and methods of obtaining the analyses of gases, with illustrative tests. Ill. 6500 w. Trans Am Inst of Mech Engs. Vol. XVIII.—May, 1897. No. 13064. 45 cts.

BOILER Construction.

Experiments in Boiler Bracing. Francis J. Cole. Investigations into the holding power, at different temperatures, of various styles of locomotive fire-box crown stays. Ill. 1800 w. Trans Am Soc of Mech Engs. Vol. XVIII.—May, 1897. No. 13059. 45 cts.

Man-Hole Frames. Discusses the necessity of providing man-holes, convenient of access, safe &c., with points of importance to be observed in construction. Ill. 1800 w. Lord's Mag—Feb., 1897. No. 12840. 15 cts.

The Reinforcing Openings in Boilers. From "The Locomotive." The details of their safe design. 1700 w. Bos Jour of Com—May 29, 1897. No. 13223. 15 cts.

BOILER Inspection.

A National Boiler-Inspection Law. E. D. Meier. Presents the need of such a law; all that has been done; other countries; and gives suggestions for early and complete accomplishment of the desired end. 4000 w. Jour Assn of Engng Soc—April, 1897. No. 13021. 30 cts.

BOILER Waters.

Boiler Waters. S. W. Parr. Classifies in a general way the waters producing harmful results, giving method of analysis. 2800 w. Technograph—No. XI. No. 13032. 45 cts.

The Cure for Corrosion and Scale from Boiler Waters. Albert A. Cary. An examination of the devices employed in skimming and filtration. Ill. 8600 w. Eng Mag—June, 1897. Serial. 4th part. No. 13265. 30 cts.

The Quality of the Boiler-Water Supply of a Portion of Northern Illinois. James A. Carney. This subject gives much trouble in Illinois, and after careful analyses the writer concludes that water for boiler purposes should be taken as much as possible from streams, lakes or artificial ponds. 2200 w. Trans Am Inst of Min Engs—May, 1897. No. 13167. 45 cts.

EXHAUST Steam.

Some Considerations of the Economical Use of Exhaust Steam. Willard T. Hatch. Read at meeting of Providence Assn. of Mech. Engs. Considers its use in the heating of buildings and the production of additional power by its use in a condensing engine. 2800 w. Ir Age—May 6, 1897. No. 12634. 15 cts.

FURNACE.

The Down-draught Furnace. A. B. Hazzard. Extract from paper read before the St. Louis Assn. No, 2. of Missouri N. A. S. E. Describes the three ways of setting a furnace, the common grate setting, the understoker, and the down draught, with the principal features of the latter. 1200 w. San Plumb—May 1, 1897. No. 12637. 15 cts.

The "Weardale" Furnace. Henry William Hollis. Abstract of paper read at the Iron and Steel Inst. Illustrated description of the furnace and mode of working. 2500 w. Eng, Lond—May 14, 1897. No. 13074. 30 cts.

RIVETING.

Hydraulic Riveting Plant—Chicago and North-Western Railway. Description with illustrations of the general arrangement of the machinery. 700 w. Am Eng & R R Jour—June, 1897. No. 13237. 30 cts.

SMOKE Prevention.

Report on Smokeless Boiler Plants in Saxony. (Bericht über Rauchfreie Dampfkesselanlagen in Sachsen.) A very full review of Prof. Lewicki's report to the Minister of the Interior, showing the performance of a great variety of furnaces and fuels. Two articles. 12000 w. Zeitsch d Ver Deutscher Ing—April 17 and 24, 1897. No. 12707. 60 cts.

COMPRESSED AIR.

AIR COMPRESSOR.

The Köster Compound Air Compressor. (Verbund Kompressor, Bauart Köster.) A tandem-compound steam engine and a tandem-compound air-compressor coupled side by side to the same shaft, with cranks at right angles. The air cylinders have mechanically-actuated valves. Efficiency 81 per cent. 3500 w. Zeitsch d Ver Deutscher Ing—April 10, 1897. No. 12703. 30 cts.

CONVERTER.

See Mining and Metallurgy, Iron and Steel.

EFFICIENCIES.

Relative Efficiencies of a Compressed Air Plant Due to Difference of Level Above and Below Sea Level. F. C. Weber. Formula and chart by use of which one may select an air compressor of sufficient capacity to supply a motor with equivalent volume of air, no matter where it may be located. 700 w. Com Air—May, 1897. No. 12964. 15 cts.

LOCOMOTIVE.

See same title under Street and Electric Railway.

MINING Purposes.

The Use of Compressed Air for Mining Purposes. Edward A. Rix. A lecture to the engineering students of Leland Stanford Jr. University. Considers compressed air the only power which is alone sufficient to supply all the power needs of an average mine. 2500 w. Min & Sci Pr—May 15, 1897. Serial. 1st part. No. 12979. 15 cts.

POWER Transmission.

Transmission of Power by Compressed Air. Richard Hirsch. From a paper read before the Eng's Soc. of W. Penn. Describes a proposed plant capable of transmitting 1100 indicated horse power, developed in the motors where used, with the cost of building and operating the same. 1700 w. Am Mfr & Ir Wld—May 14, 1897. No. 12889. 15 cts.

ENGINES AND MOTORS.

BALANCING.

The Influence and Balancing of Moving Masses in Steam Engines. (Die Massenwirkungen der Dampfmaschinen und ihre Balancirung.) A geometrical investigation, including simple and multiple-expansion engines with various crank relations. 5000 w. Zeitschr d Oesterr Ing u Arch Ver—April 30, 1897. No. 12725. 30 cts.

COUPLING.

Theory of Coupling and Connecting Rods. Ivanhoff Veder. Considers the case in relation to slow-running and also high-speed engines. 600 w. Prac Eng—May 21, 1897. Serial. 1st part. No. 13214. 30 cts.

CYLINDER Dimensions.

Method for Determining Cylinder Dimensions for Multi-Cylinder Steam-Engines. A. W. Smith. The method is a modification of Prof. Unwin's method, extended to triple expansion, and may be applied to four or more cylinders. 2500 w. Engng Jour—May, 1897. No. 13121. 30 cts.

EFFICIENCY.

The Efficiency of Steam Engines. Considers briefly several standards of efficiency. 1000 w. Am Eng & RR Jour—June, 1897. No. 13234. 30 cts.

ELECTRIC Motor.

The Use of Electric Motors in Machine Shops. Charles H. Benjamin. Discusses the application of electricity to machine tools from the standpoint of the manufacturer and of the mechanical engineer, with a view of determining under what circumstances it is profitable to use that system of power-transmission. 4400 w. Jour Assn of Engng Soc—April, 1897. No. 13014. 30 cts.

ENGINE Proportions.

Current Practice in Engine Proportions. John H. Barr. Results of investigations made upon "low-speed"-engine proportions, with several interesting diagrams. 4000 w. Trans Am Soc of Mech Engs—Vol. XVIII. May, 1897. No. 13062. 45 cts.

ENGINE Tests.

Tests of Three Sulzer Engines. Hamilton A. Hill. Reports of three tests of large mill engines, built by Messrs. Sulzer Bros., Winterthur (Switzerland), which show unusually fine results. Ill. 2400 w. Trans Am Soc of Mech Engs—Vol. XVIII. May, 1897. No. 13067. 45 cts.

EXPLOSION Engine.

The Modern Explosion Engine. E. S. Savage. Discusses the requisites of the explosion engine and its advantages, admitting the imperfections, but predicting a bright future. 2500 w. Eng's Year Book, Univ of Minn. 1897. No. 13009. 45 cts.

FANS.

See Mechanical Engineering, Miscellany.

GAS Engine.

A Practical Illustration of the Working of a Large Gas Engine. Ernest F. Lloyd. Gives curve of average working taken from engine at Lancaster, Ohio, with comments. 900 w. Am Gas Lgt Jour—May 17, 1897. No. 12927. 15 cts.

Gas-Engine Requirements. Sidney A. Reeve. An indictment of the shortcomings of gas-engine builders. 2400 w. Elec—May 12, 1897. No. 12862. 15 cts.

See same title under Electrical Engineering, Light.

HIGH-SPEED Engines.

The Rapid Coming in of High-Speed Engines. States their advantages, and the objections when they are built on low-speed models. 3300 w. Engng Mech—April, 1897. No. 12640. 30 cts.

INDICATOR.

A Continuous Steam-Engine Indicator. Thomas Gray. The instrument described was devised with the object of obtaining a record of the performance of a gas engine during a series of successive cycles of operation. Ill. 2000 w. Trans Am Soc of Mech Engs—Vol. XVIII. May, 1897. No. 13057. 45 cts.

INDICATOR Diagram.

Effect of Piping Arrangements on the Indicator Diagram. D. T. Randall. Experiments with such a selection of data as will best show the differences in results obtained under various conditions of cut-off and pipe lengths. 1500 w. Technograph—No. XI. No. 13031. 45 cts.

LOADING.

The Best Load for the Compound Steam Engine. Albert K. Mansfield. Graphical record of tests of two compounds of Buckeye Engine Co.'s make, both condensing engines, with brief explanation. 500 w. Trans Am Soc of Mech Engs—Vol. XVIII. May, 1897. No. 13066. 45 cts.

OSCILLATING Engine.

Acceleration Diagram for the Oscillating Engine. A. C. Elliott. Acceleration diagrams for the oscillating engine are given and the constructions explained. 1000 w. Engng—May 21, 1897. No. 13151. 30 cts.

PETROLEUM Engines.

Petroleum Engines. Frederick Grover. Part first examines the physical properties of the oil which more directly affect the design of oil engines, and the construction of some early types. Ill. 1300 w. Prac Eng—May 7, 1897. Serial. 1st part. No. 12919. 30 cts.

The Peugeot Petroleum Motor. Describes a recently designed motor, to be used in mechanically propelled carriages. Ill. 2000 w. Engng—May 21, 1897. No. 13152. 30 cts.

WET Steam.

Tests to Show the Influence of Moisture in Steam in the Economy of a Steam Turbine. D. S. Jacobus. Gives conditions of tests and the results. 1300 w. Trans Am Soc of Mech Engs, Vol. XVIII. May, 1897. No. 13054. 45 cts.

STEAM Engines.

The Steam Engines at the Electrical and Technical Exposition at Stuttgart, 1896. (Die Dampfmaschinen auf der Ausstellung für Elektrotechnik und Kunstgewerbe in Stuttgart 1896.) A fully illustrated description of some excellent simple and compound engines adapted for electrical service. 5000 w. Zeitschr d Ver Deutscher Ing—May 8, 1897. No. 12712. 30 cts.

The History and Structure of the Steam Engine. Robert H. Thurston. Early history of the steam engine. First of a series of twelve articles to describe and illustrate the birth and growth of the steam engine to date. Abstracted from "The Manual of the Steam Engine." 6500 w. Ry Mag—April, 1897. Serial. 1st part. No. 12837. 30 cts.

THERMODYNAMICS.

The Heat Diagram of Saturated Vapors, and its Applications to Heat and Cold Engines. (Das Wärme Diagramm der Gesättigten Dämpfe und seine Anwendung auf Heis- und Kalt Dampfmaschinen.) An analytical and geometrical investigation of the entropy diagram by Prof. Ancona, of Milan. Two articles. 10000 w. Zeitsch d Ver Deutscher Ing—April 17, and May 15, 1897. No. 12706. 60 cts.

VALVE Diagram.

The Bicentric Slide-Valve Diagram. (Das Bizentrische Polare Exzenterschieber Diagramm.) A new diagram by chief engineer Brix, of the Russian navy. It determines the valve positions taking into account the angular deviations of the valve and connecting rod. 3000 w. Zeitschr d Ver Deutscher Ing—April 10, 1897. No. 12705. 30 cts.

VALVES.

Valve Lifts. Herbert Aughtie. Diagrams of various valves are given and studied. 1100 w. Prac Eng—May 14, 1897. No. 13115. 30 cts.

WELLINGTON Engine.

The Wellington Engine and Modern Steam-Engine Efficiency Compared. Henry E. Longwell. Exceptions taken to statements made in an article published in this paper, April 21, on the Wellington series engine, with examination of the system. 1200 w. Elec Eng—May 5, 1897. No. 12629. 15 cts.

The Wellington Series Engine. J. E. Johnson, Jr. A criticism of the conception on which Mr. Wellington's ideas are based and concluding that the best steam engines of to-day are as economical as it is commercially practicable to make them. 1200 w. Eng & Min Jour—May 8, 1897. No. 12649. 15 cts.

WIRE Drawing.

Loss by Wire Drawing. W. H. Booth. Shows there is no loss from wire drawing of steam, but that such wire drawing is probably not to be economically employed in place of expansion, save where expansive working is being carried to excess. 1800 w. Mach, N. Y.—June, 1897. No. 13227. 15 cts.

POWER AND TRANSMISSION.

DYNAMOMETER.

A Design for a Dynamometer. L. M. Hoskins. The device is described and illustrated. 800 w. Engng Jour—May, 1897. No. 13122. 30 cts.

A New Form of Transmission Dynamometer. Frederick Bedell. Describes an ingenious device that has been used in the laboratories of Cornell University. 900 w. Trans Am Soc of Mech Engs—Vol XVIII. May, 1897. No. 13065. 45 cts.

POWER Transmission.

The Comparative Economy of Power Transmission by Gas and by Electricity. Questioning statements made in a paper by Nelson W. Perry. 1500 w. Eng News—May 13, 1897. No. 12880. 15 cts.

Electricity versus Shafting in the Machine Shop. Charles H. Benjamin. Showing the economic advantages of the newer system. 4800 w. Trans Am Soc of Mech Engs—Vol. XVIII. May, 1897. No. 13063. 45 cts.

PROPULSION.

Mechanical Propulsion on Canals. Leslie S. Robinson. Read before the Inst. of Mech Engs. A review of the general question of propulsion or haulage on canals. Also discussion. 7500 w. Engng—April 30, 1897. Serial. 1st part. No. 12686. 30 cts.

STEAM Power.

See Mining and Metallurgy, Iron and Steel.

WATER-WHEELS.

Report of Tests of a 28-inch and 36-inch "Cascade" Water-Wheel Made at the Mechanical Engineering Laboratory of the Ohio State University. Abstract by John H. Cooper. A brief illustrated description of the "Cascade" wheel, with results of a series of tests. 700 w. Jour Fr Inst—May, 1897. No. 12647. 45 cts.

The Principles and Construction of Water-Wheels. W. E. Wines. Read before the Technical Soc. of Armour Inst., Chicago. A few fundamental principles relative to the efficiency of water-wheels in general and to the action of a jet of water upon a vane are laid down, followed by discussion of different classes of water-wheels. 1600 w. Elec Eng—May 12, 1897. Serial. 1st part. No. 12853. 15 cts.

WIND Power.

The Utilization of Wind as a Motive Force. Illustrated description of some modern windmills and a comparison of their advantages with steam power. 1100 w. Mach, Lond—May 15, 1897. Serial. 1st part. No. 13119. 30 cts.

See also "Factories," "Marine Engineering," "Manufacturing Plants," "St. Anthony's Falls," and "Transmission" under Electrical Engineering, Power.

See also "Power Transmission" under Mechanical Engineering, "Compressed Air."

SHOP AND FOUNDRY.

ALUMINUM.

The Working of Sheet Aluminum. From the Aluminum World. Describes lathe work, drawing, spinning, frosting, burnishing. 2500 w. Met Work—May 15, 1897. No. 12876. 15 cts.

BORING.

Universal Boring, Drilling and Milling Machine. Illustrated description of a piece of heavy-tool construction recently supplied by Bement, Miles & Co. to the Bethlehem Iron Co. 1000 w. Am Mach—May 6, 1897. No. 12658. 15 cts.

CASTINGS.

Volumnar Contraction of Castings in Cooling. Francis Schumann. This paper contains addenda to the paper entitled "Contraction and Deformation of Iron Castings in Cooling from the Fluid to the Solid State" and is intended to open and continue discussion on that subject. 500 w. Trans Am Soc of Mech Engs—Vol. XVIII. May, 1897. No. 13052. 45 cts.

CHILLED Iron.

Chilled Iron and Chilling Iron. E. E. Putnam. Read before the convention of the American Foundrymen's Assn. Discusses the crystalline texture, chilled plows, the difficulties in making clean chilled work, &c. 4000 w. Tradesman—May 15, 1897. No. 12933. 15 cts.

CIRCULAR Work.

Fixture for Milling Circular Work. Ed. Snyder. Illustrated description of device designed by the writer. 900 w. Am Mach—May 20, 1897. No. 12965. 15 cts.

CLUTCHES.

Coil Clutches. Describes Lindsay's clutches, manufactured by the Coil Clutch & Pulley Co., of Gotha Works, Slough. Explains the principle and the various forms. 1500 w. Engng—May 7, 1897. No. 12898. 30 cts.

CUPOLAS.

On the General Utility and Economy of Central-Blast Cupolas. Thomas D. West. A discussion of the advantages and sources of economy obtained by the use of the central blast, with outside tuyeres. 3000 w. Ind & Ir—May 14, 1897. No. 13081. 30 cts.

The Cupola and What Goes On in It. A. Humboldt Sexton. Discusses the phenomena attending the melting of pig iron. 2500 w. Prac Eng—May 14, 1897. Serial. 1st part. No. 13114. 30 cts.

CUTTERS.

Inside Pipe Cutters. E. J. Prindle. Illustrated description of various forms of this tool. 1700 w. Loc Engng—May, 1897. No. 12674. 30 cts.

CUTTING.

Cutting Semi-Cylindrical Concavities. B. F. Spalding. Common tools inadequate; grubbing; form of cutter; mode of motion; making joint for vise hinge. Ill. 1800 w. Am Mach—May 6, 1897. No. 12661. 15 cts.

To Cut a Thing in Two and Yet Not Separate It. John H. Cooper. Describes an interesting device which has been several times reinvented. Ill. 700 w. Mach, N. Y—June, 1897. No. 13226. 15 cts.

ELECTRICAL Machinery.

How to Calculate, Design and Construct Electrical Machinery. William Baxter, Jr. The first of a series of articles which proposes to explain in a simple manner the principles upon which electrical machinery acts, and also to give such rules as may be necessary to enable one to calculate the various parts of such machines. 3000 w. Mach, N. Y—June, 1897. Serial. 1st part. No. 13229. 15 cts.

ELECTRICITY.

Electricity in the Modern Machine Shop. Louis Bell. Setting forth the reasons that determine the choice of electric motive-power. Ill. 3600 w. Eng Mag—June, 1897. Serial. 1st part. No. 13258. 30 cts.

FLY-WHEELS.

A Canadian Example of Heavy Fly-Wheel Construction. Illustrated description of processes used in the construction of heavy fly-wheels. Taken from the Laurie Engine Company's shops, at Montreal. 800 w. Am Mach—June 3, 1897. No. 13245. 15 cts.

FOUNDRY.

Foundry Elevators and Yard Cranes. G. A. True. Read at convention of the American Foundrymen's Assn. Describes devices introduced in modern foundries with great advantage. Ill. 2000 w. Ir Trd Rev—May 20, 1897. No. 13043. 15 cts.

GEAR Teeth.

Helical Gear Teeth. A. M. Mortley. An illustrated description of method of building helical gears. 800 w. Mach, N. Y—June, 1897. No. 13230. 15 cts.

Diagrams for Relative Strength of Gear Teeth. Forrest R. Jones. Diagrams constructed with a view to facilitating the determining of the sizes and pitches of gears which are suitable to withstand a known or assumed pressure transmitted to them by an intermeshing gear. 2200 w. Trans Am Soc of Mech Engs—Vol. XVIII. May, 1897. No. 13068. 45 cts.

GEAR Wheels.

The Construction of Cast-Iron Gear Wheels. Herbert Aughtie. Suggests a method of moulding gear wheels that does not involve the use of a machine, while at the same time largely avoiding the sources of expense and inaccuracy inherent in the alternative methods in general use. 2000 w. Prac Eng—April 23, 1897. No. 12606. 30 cts.

GRINDING.

Machine Grinding. C. H. Norton. The article is written to help clear away misunderstandings, and open the way to the more profitable use of grinding. Part first gives suggestions for using the grinding machine successfully. 3000 w. Am Mach—May 6, 1897. Serial. 1st part. No. 12659. 15 cts.

MOLDING.

An Unusually Difficult Molding. Describes and illustrates an interesting work connected with the manufacture of heaters made by the Mitchell Heater Co., of Poughkeepsie, N. Y. 700 w. Ir Age—May 13, 1897. No. 12860. 15 cts.

PATTERN Making.

Practical Pattern Making. I. McKim Chase. Part first refers to the materials that have been used in pattern making, and the various methods of molding. 2500 w. Mach, N. Y.—June, 1897. Serial. 1st part. No. 13228. 15 cts.

PLANER.

A New Planer Drive. John Randol. Describes and approves the Whitcomb planer and pronounces the "bull wheel" an unwarranted construction expense, apparently serving no useful purpose. Ill. 1100 w. Am Mach—May 13, 1897. No. 12891. 15 cts.

Something New in Planers. Illustrates and briefly describes a pneumatic reverse planer, the

invention of Alexander Gordon, and brought out by the Niles Tool Works. 600 w. Am Mach—May 13, 1897. No. 12892. 15 cts.

TEMPERING.

Practical Tempering of Steel. W. B. Braucher. Describes peculiarities of steel noticed while working with several kinds of steel in the same set of knives which were being re-sharpened and hardened. 1500 w. Technograph—No. XI. No. 13030. 45 cts.

TOOLS.

The Resistance of Metals to Machining. (Die Grösse der Widerstände gegen das Abheben von Metallspänen.) An investigation into the resistance of metals to planing, boring, turning, &c., based upon experimental data, for use in determining the proportions of machine tools. 5000 w. Zeitschr d Ver Deutscher Ing—May 1, 1897. No. 12710. 30 cts.

Two Valuable Shop Tools.—L. & N. Ry. Illustrated description of a 25-ton hydraulic press, and a drill-press link-slotter used in the Louisville shops of this road. 1400 w. Ry Mas Mach—May, 1897. No. 12695. 15 cts.

In the Shops. Illustrated description of the reconstruction of old machines for the performance of special work. 600 w. Ry Age—May 7, 1897. No. 12828. 15 cts.

MISCELLANY.

ACCELERATIONS.

The Accelerations of the Links of a Mechanism. G. A. Goodenough. The object of the article is to apply stated principles and constructions to one or two simple mechanisms and thus furnish concrete examples for the aid of those who wish to study this subject. Diagrams. 2300 w. Technograph—No. XI. No. 13027. 45 cts.

AERONAUTICS.

Our Teachers in Sailing Flight. Otto Lilienthal. An account of the writer's observation of storks in the village of Vehlin in Ostprignitz. 2700 w. Aeronautical Annual—1897. No. 13204. $1.

Recent Advances Toward a Solution of the Problem of the Century. A. M. Herring. The writer classifies all methods under four heads and examines the advantages and disadvantages of each class, reviewing the work in this field. Ill. 8500 w. Aeronautical Annual—1897. No. 13203. $1.

Recent Experiments in Gliding Flight. O. Chanute. The author reached the conclusion that the maintenance of the equilibrium under all circumstances, was the most important problem to solve. The article gives the experiments made and illustrates and describes the designs used, giving the degree of success attained by the apparatus, and much information. 8000 w. Aeronautical Annual—1897. No. 13202. $1.

Screw-Propellers Working in Air. Hiram S. Maxim. Brief account of experiments. 1000 w. Aeronautical Annual—1897. No. 13206. $1

Story of Experiments in Mechanical Flight Samuel Pierpont Langley. A narrative account of the writer's work in aerodromics, and of the successful flight of his aerodrome. Ill. 6500 w. Aeronautical Annual—1897. No. 13201. $1.

The "Flying Machine." S. P. Langley. An informal and popular account of the author's experiments with flying-machines, built chiefly of steel, driven by steam-engines. Ill. 8000 w. McClure's Mag—June, 1897. No. 13162. 15 cts.

The Way of An Eagle in the Air. E. C. Huffaker. A study of the art of soaring, with account of experiments. 6400 w. Aeronautical Annual—1897. No. 13205. $1.

ANGULAR VELOCITY.

On a Means of Producing a Constant Angular Velocity. A. G. Webster. Describes an arrangement used by the writer, with practical test of the method, showing it to be of undoubted usefulness in absolute determinations. 1500 w. Am Jour of Sci—May, 1897. No. 12609. 45 cts.

BELTING.

Rules for Belting. Presents conclusions arrived at from practical rather than theoretical considerations with a view to drawing out discussion. A nine-years' experiment in belting in the machine shop of the Midvale Steel Co., Phila., is given. 3000 w. Engng Mech—May, 1897. No. 13022. 30 cts.

BICYCLES.

The Women's Bicycle and Its Predecessors. E. D. Sewall. Illustrated historical account of the development of the bicycle, especially as used by women. 6000 w. Ir Age—May 6, 1897. Serial. 1st part. No. 12633. 15 cts.

CHEMISTRY.

Chemistry as an Elective for Engineers. F. F. Sharpless. Showing the importance of chemistry in the practice of the engineering profession. 3400 w. Eng's Year Book, Univ of Minn.—1897. No. 13002. 45 cts.

CONDENSATION.

The Laws of Cylinder Condensation. Arthur L. Rice. Studies the action of condensation, and the factors that control it. Gives formula for estimating condensation, and table of data. 7200 w. Trans Am Soc of Mech Engs-Vol. XVIII.—May, 1897. No. 13060. 45 cts.

DISCUSSIONS.

Topical Discussions and Notes of Experience. Steam distribution at early cut-off, by E. J. Armstrong. Tests of the efficiency of the bicycle, by Jno. G. D. Mack; Note on old windmill gearing, by C. W. Hunt; Basement floors for machine shops, by Jno. E. Sweet: Crystallization by shock, by Gus. C. Henning. 5700 w. Trans Am Soc of Mech Engs-Vol. XVIII—May, 1897. No. 13053. 45 cts.

EXTENSIMETER.

A Mirror Extensimeter. Gus. C. Henning. Illustrated description of a form of this apparatus designed by the writer to simplify and facilitate its use. Ill. 1800 w. Trans Am Soc of Mech Engs-Vol. XVIII—May, 1897. No. 13051. 45 cts.

FANS.

Experiments upon Propeller Ventilating-Fans, and Upon the Electric Motor Driving Them. William George Walker. Read before the Inst. of Mech Engs. Illustrated description of experiments made on propeller ventilating-fans. 2000 w. Elec Eng, Lond—May 14, 1897. No. 13100. 30 cts.

FORMULAE.

Formulæ Explained. Otto Dietrich. The

first of a series of articles explaining matters not understood by all engineers, mostly of a mathematical character. 1000 w. Sta Eng—May, 1897. Serial. 1st part. No. 12657. 15 cts.

INSPECTION.

Inspection—Its Place in Modern Engineering Practice. A. C. Beyer. Some account of the methods employed and work accomplished by inspectors. 2500 w. Eng's Year Book, Univ of Minn—1897. No. 13004. 45 cts.

INVENTION.

Cultivation of the Inventive Faculty by the Solution of Constructive Problems. Leicester Allen. Presentation of two solutions of problem 8, with comments. 1100 w. Am Mach—May 13, 1897. No. 12893. 15 cts.

INVENTOR.

The Story of an Inventor. William Walsh. Reprint from Overland Monthly. History of the patent case of A. B. Bowers. 8000 w. Overland M—Feb., 1897. No. 12671. 45 cts.

JOURNALS.

Experiment with an Air-Lubricated Journal. Albert Kingsbury. Describes an apparatus for exhibiting the action of fluid lubricants in cylindrical bearings, with a statement of results of a large number of tests made at various speeds, measuring the pressures in the lubricant, thickness of the film of lubricant, and the friction. Ill. 6000 w. Jour Am Soc of Nav Engs—May, 1897. No. 12912. $1.25.

LUBRICATION.

Slide Valve and Cylinder Lubrication. Editorial discussion of this subject, calling attention to defects, and a consideration of the devices in use. 1800 w. Ry Rev—May 15, 1897. No. 12951. 15 cts.

MACHINE Design.

English Practice in Machine Design. (Aus der Praxis des Maschinenbaues der Engländer.) An interesting review of the differences between English and Continental practices, by an Austrian engineer resident in England. 3000 w. Zeitschr d Oesterr Ing u Arch Ver—April 16, 1897. No. 12721. 30 cts.

MOTOR Carriage.

The Columbia Electric Motor Carriage. Illustrated detailed description. 3300 w. Elec Wld—May 15, 1897. No. 12944. 15 cts.

OMNIBUS.

The Weidknecht Steam Omnibus. (L'Omnibus à Vapeur Système Weidknecht.) Illustrated description of the motor omnibus now in operation on the *boulevard extérieur* in Paris. A speed of 7½ miles an hour is obtained at a cost of 15 pounds of coke per mile. 2000 w. Le Génie Moderne—April 15, 1897. No. 12739. 30 cts.

PISTOL.

The New Recoil Pistol. (Der Neue Pistole Rückstosslader.) A paper by H. Mauser upon a new magazine pistol which is reloaded automatically by the action of the recoil. Details fully illustrated. 3500 w. Zeitsch d Ver Deutscher Ing—May 1, 1897. No. 12711. 30 cts.

PRESSURES.

An Apparatus for Accurately Measuring Pressures of Ten Thousand Pounds per Square-Inch and Over. D. S. Jacobus. Brief illustrated description. 300 w. Trans Am Soc of Mech Engs—Vol. XVIII. May, 1897. No. 13058. 45 cts.

PUMPS.

About Steam Pumps. Thomas Shelton. Extract from a lecture before an engineer's association discussing the various kinds and their valves. 1800 w. Bos Jour of Com—May 15, 1897. No. 12885. 15 cts.

PYROMETER.

The Actinometric Pyrometer. (Pyromètre Actinométrique). A description of the Latarche pyrometer, which measures the difference in temperature by observing the effect of radiant heat upon two thermometers with silvered and blackened bulbs, respectively. 1000 w. La Revue Technique—April 10, 1897. No. 12732. 45 cts.

RECORDER.

A Pocket Recorder for Tests of Materials. Gus C. Henning. Describes an instrument designed to be used on any and all machines which have a running poise weight, without causing delay for adjustment, the results at the same time being reliable, and such that they can be at once interpreted. Ill. 2500 w. Trans Am Soc of Mech Engs—Vol. XVIII. May, 1897. No. 13050. 45 cts.

REVOLVERS.

The Manufacture of the Colt Navy Revolver, Model 1895. Describes the revolver and the manufacture of the several parts, especially the operations that are novel. Ill. 3000 w. Ir Age—May 27, 1897. No. 13120. 15 cts.

STEAM Plant.

The Operation of a High-Pressure Multiple-Expansion Steam Plant. Frederick L. Ray. Discusses the boiler appliances and engine of a steam-heating plant. 4000 w. St Ry Rev—May 15, 1897. No. 12958. 30 cts.

TRAFFIC.

Motor Traffic. Technical Considerations. Sir David Salomons. The subject of self-propelled traffic is discussed and the writer thinks benzine motors probably have the advantage. Steam promises to be the power when real work is called for and electric energy has a great field in towns as a luxury. Also discussion. 15400 w. Jour Soc of Arts—May 14, 1897. No. 13096. 30 cts.

WATER Wheels.

Care of Water Wheels. Points out how wheels are destroyed and suggests points needing attention. 2000 w. Lord's Mag—June-1897. No. 13248. 15 cts.

MINING AND METALLURGY.

COAL AND COKE.

BREAKER.

A Welsh Coal Breaker. Illustrated description of the anthracite coal breaker at the Glyncastle colliery, South Wales. 1100 w. Col Eng—May, 1897. No. 12973. 30 cts.

COALFIELD.

The Hougay and Hatou Coalfield (Tonkin).

F. Brard. Describes the coal and method of mining. 1200 w. Col Guard—April 30, 1897. No. 12692. 30 cts.

COAL Handling.

Modern Methods of Handling and Storing Coals. F. D. Marshall. Read at meeting of Inst of Gas Engs., London. Describes machinery for discharging the bulk of the coals from steamers and storing the same. Discussion. 4200 w. Gas Wld—May 8, 1897. No. 12991. 30 cts.

The Treatment of Coal. Summary of an interesting discussion on two papers read at meeting of Inst. of Civ. Engs. "Tipping and Screening Coal" by James Rigg and "The Surface Plant at Kirkby Colliery" by Thomas Gillott. Ill. 6500 w. Col Guard—May 21, 1897. No. 13208. 30 cts.

COKE.

Report of the Westphalia Coke Syndicate for 1896. (Geschäftsbericht des West fälischen Kokssyndkats für das Jahr 1896.) A very full tabular report of the coke industry in its German headquarters with graphical diagrams of the relative production in Germany and the rest of the world. 7500 w. 2 plates. Glückauf—April 17, 1897. No. 12787. 30 cts.

COLORADO.

Colorado's Oil and Coal Fields. C. L. Hall. Description of the region about Florence, Col. 3500 w. Min Ind & Rev—May 20, 1897. No. 13110. 15 cts.

ELECTRICITY.

Electricity in Coal Mining. Harry N. Gardner. Illustrated description, showing the economical results of applying electricity to mining purposes, as exhibited in the anthracite mines of the New York and Scranton Coal Co., located at Peckville, Pa. 2800 w. Elec Eng—May 5, 1897. No. 12627. 15 cts.

FANS.

The Design and Testing of Centrifugal Fans. Hammersley Heenan and William Gilbert. Read before the Inst. of Civ Engs., London. A record of experiments made by the authors on several of the best known varieties of fans in use, for the object of finding the best type of fan and obtaining data whereby the proper diameter of the standard fan and its most economical speed could be determined for any required output of air at a given pressure. 6500 w. Jour Am Soc of Nav Engs—May, 1897. No. 12913. $1.25.

The Design and Testing of Centrifugal Fans. A summary of the discussion of a paper on this subject, by Hammersley Heenan and William Gilbert. 8500 w. Col Guard—April 30, 1897. No. 12689. 30 cts.

The Design and Testing of Centrifugal Fans. Correspondence arising from the paper on this subject, by Messrs Heenan and Gilbert, read before the Inst. of Civil Engs. 5400 w. Col Guard—May 9, 1897. No. 12904. 30 cts.

FIREDAMP.

Study of Firedamp Composition. From the Annales des Mines. Investigation to ascertain whether firedamp does not contain a small quantity of other gases, beside methane, equally combustible. 2000 w. Col Guard—May 7, 1897. Serial. 1st part. No. 12903, 30 cts.

HYGROMETRIC Properties.

Hygrometric Properties of Coals. R. C. Carpenter. Describes investigations undertaken to ascertain the relative qualities of various coals with reference to absorbing moisture from the atmosphere. 800 w. Trans Am Soc of Mech. Engs—Vol. XVIII. May, 1897. No. 13048. 45 cts.

KIRKBY.

The Surface Plant at Kirkby Colliery. Thomas Gillott. Read before the Inst. of Civ. Engs., England. Illustrated detailed description. 2800 w. Col Guard—May 14, 1897. No. 13070. 30 cts.

LIGNITE.

The Mining and Utilization of the Rhenish Lignites. (Die Gewinnung und Verwertung der Braunkohle im Rheinlande.) Giving several designs of successful furnaces for burning these low grade fuels without previous preparation. 1200 w. Zeitschr d Ver Deutscher Ing—April 3, 1897. No. 12701. 30 cts.

PRODUCTION.

Coal Production in 1896. Statistics as recently published by Messrs. Adler & Ruley, of Philadelphia, are given, with remarks. 800 w. RR Gaz—May 28, 1897. No. 13149. 15 cts.

SCREENING.

Tipping and Screening Coal. James Rigg. Read before the Inst. of Civ. Engs. These processes are considered separately and the methods illustrated. 5000 w. Col Guard—April 30, 1897. No. 12691. 30 cts.

SILESIA.

The Witkowitz Coal Mines at Petrzkowitz, in Prussian Silesia. (Der Witkowitzer Steinkohlengruben in Petrowitz, Preussische-Schlesien.) A descriptive account of these important coal mines, with map. 5000 w. Oesterr Zeitschr f Berg u Hüttenwesen—April 17, 1897. No. 12775. 30 cts.

WASHER.

Wunderlich Coal Washer. From Glückauf. Gives vertical section and describes a washer by which the mineral, uniformly fed in, is separated into clean coal, shaly coal, and stone, according to the specific gravity. 900 w. Col Guard—April 30, 1897. No. 12690. 30 cts.

COPPER.

BESSEMERIZING Mattes.

Standard Practice in Bessemerizing Copper Mattes. C. W. Parsons. The article is limited to the practical details of converter work with particular reference to a 5 ft. x 8½ ft. upright converter. 2500 w. Eng & Min Jour—May 15, 1897. No. 12946. 15 cts.

GOLD AND SILVER.

ASSAY.

Anyone Can Assay. Alex. Roy. Describes an easy method of making a test for gold. 900 w. Can Eng—May, 1897. No. 12832. 15 cts.

ASSAY-MUFFLE.

An Improved Assay-Muffle. Arthur S. Dwight. Calls attention to an improvement on the method of temperature-regulation, which has been in use in the assay department of the Colorado Smelting Co., at Pueblo, and was devised by Howard F. Wierum, with the co-

operation of F. L. Capers. 1000 w. Trans Am Inst of Min Engs—May, 1897. No. 13163. 45 cts.

BOLIVIA.

The Tipuani Gold-Fields of Bolivia. William C. Agle. An account of the mines of this region and the great resources of the country. 1400 w. Eng & Min Jour—May 29, 1897. No. 13181. 15 cts.

BRITISH COLUMBIA.

British Columbia—The Big Bend District, West Kootenay. Frank L. Nason. Descriptive of the country, the mining claims already located, and the prospecting that has been done. 2400 w. Eng & Min Jour—May 8, 1897. No. 12651. 15 cts.

CANADA.

The Occurrence of Gold Ores in the Rainy River District, Ontario, Canada. William Hamilton Merritt. Describes the general characteristics of the rocks, veins, &c., with the opinion of the writer that as large a proportion of paying gold mines will be found in this region, as are found on an average in successful mining districts. Ill. 2800 w. Trans Am Inst of Min Engs—May, 1897. No. 13174. 45 cts.

COLORADO.

Geology of the Four-Mile Placer Mining Districts, Colorado. Herbert C. Hoover. The geology, method of deposition, and origin of gravel and the gold are discussed. 1900 w. Eng & Min Jour—May 22, 1897. No. 13038. 15 cts.

COLORADO River.

The Gold Belt of the Lower Colorado River. Taylor D. MacLeod. A brief review of the conditions of this district and the values in gold as found in the better-known prospects and mines. 2500 w. Min & Sci Pr—May 8, 1897. No. 12864. 15 cts.

CONCENTRATION.

Some Colorado Concentration Methods. Ph. Rearden. Suggestions from the extensive experience of the writer. 1200 w. Min & Sci Pr—May 15, 1897. No. 12978. 15 cts.

CONCENTRATORS.

Nature's Concentrators. Alfred C. Lane. Traces the analogy between the natural and artificial processes, and draws conclusions therefrom. 2800 w. Eng & Min Jour—May 29, 1897. No. 13180. 15 cts.

CYANIDE.

The Cyanide Patent. G. Massey. Particulars prepared for the benefit of a meeting to take steps to contest the amendment of the cyanide patent. Claiming the right of free use of the dilute solution of cyanide for the extraction of precious metals. 2200 w. Aust Min Stand—April 8, 1897. No. 12849. 30 cts.

GOLD Ores.

Free Milling and Chlorination of Gold Ores at North Brookfield, Queen's County, N. S. A detailed description of this new plant, which has cost over $80,000, and the process used. 2000 w. Can Min Rev—May, 1897. No. 13246. 30 cts.

GEORGIA.

The Villa Rica Mining District, Georgia. W. M. Brewer. Report from personal examination of this district, giving the properties purchased since 1895. 1000 w. Eng & Min Jour—May 15, 1897. No. 12947. 15 cts.

GOLD Field.

The Great Northern Gold Field. Almarin B. Paul. Information of the mining region of northern California and northern Oregon. 1200 w. Min & Sci Pr—May 1, 1897. No. 12666. 15 cts.

HAHN'S Peak.

Hahn's Peak Mining Region. Marshall Draper. A description of some of the geological features of one of the newest Colorado mining camps. 1800 w. Col Eng—May, 1897. No. 12974. 30 cts.

MEXICO.

The Mineral District of Hidalgo del Parral, Mexico. S. E. Gill. Describes the region and the operations of the leading company. 900 w. Eng & Min Jour—May 22, 1897. No. 13037. 15 cts.

ONTARIO.

The Mines of Ontario. J. F. Whitson. Read before the Assn. of Ontario Land Surveyors. Information gathered during two years of active exploration. 2000 w. Can Eng—May, 1897. No. 12833. 15 cts.

PERU.

The Gold Fields of Sandia, Peru. H. Tweddle. Illustrated description and historical account, giving the geological formation, deposits, workings, etc. Part first treats of Poto, and San Juan del Oro. 2800 w. Eng & Min Jour—May 8, 1897. Serial. 1st part. No. 12650. 15 cts.

RICO, Colorado.

The Enterprise Mine, Rico, Colorado. T. A. Rickard. Gives the history of the discovery, describes the rock, ore-occurrence, veins, cross-veins, &c. Ill. 13500 w. Trans Am Inst of Min Engs—May, 1897. No. 13165. 45 cts.

SECONDARY Minerals.

The Formation of Secondary Minerals in Ore Bodies. E. Moriarty Weston. Notes on their occurrences on the west coast of Australia and elsewhere. 2400 w. Aust Min Stand—March 18, 1897. No. 12652. 30 cts.

SMELTING.

A Modern Silver-Lead Smelting-Plant L. S. Austin. Discussion of Mr. Austin's paper by Henry A. Vezin. Argues in favor of works on a level, considering the good ventilation worth the extra cost, and discusses related subjects. 2700 w. Trans Am Inst of Min Engs—May, 1897. No. 13164. 45 cts.

SORTING.

Sorting before Sizing. Robert H. Richards. Describes investigations made in studying this question, with data upon the laws defining the water-quantity and slope-angle best adapted for the treatment of the different slime-sorts upon slime-tables. 5000 w. Trans Am Inst of Min Engs—May, 1897. No. 13175. 45 cts.

SOUTH AUSTRALIA.

The Arltunga Goldfield, South Australia. H. T. L. Brown. Extract from a recently issued report of this new field. Map. 4300 w. Aust Min Stand—March 25, 1897. Serial. 1st part. No. 12845. 30 cts.

SOUTH DAKOTA.

Notes on the Northern Black Hills of South Dakota. Persifor Frazer. An examination of

the geology of this region, with microscopical examination of the concentrates, and description of the Coletta group of mines. 8400 w. Trans Am Inst of Min Engs—May, 1897. No. 13173. 45 cts.

STAMP Mills.

Gravitation Stamp Mills for Quartz Crushing. D. B. Morison. Read before the North-east-Coast Inst. of Engs & Shipbuilders, Newcastle-upon-Tyne. An analysis of the mechanics of the gravitation stamp battery, describing some recent developments. Ill. 3000 w. Ind & Ir—May 7, 1897. Serial. 1st part. No. 12922. 30 cts.

TAILINGS.

The Loss of Gold in Waste Tailings. Henry Rosales. An account of examinations made to determine the actual loss of gold as carried away in waste tailings. 2800 w. Aust Min Stand—April 8, 1897. No. 12847. 30 cts.

TRANSVAAL.

Gold Mining in the Transvaal. (L'Exploitation Minière de l'Or au Transval.) Giving an account of the working of poor ores in *situ* by the Frasch chlorination process. The solution is circulated through the ore bed by pumping. 2500 w. La Revue Technique—April 25, 1897. No. 12735. 45 cts.

VICTORIA.

Notes on the Geology of the Victorian Coal Fields and Output. James Stirling. Describes the existing conditions of these coal fields. 1400 w. Aust Min Stand—March 18, 1897. Serial. 1st part. No. 12654. 30 cts.

The Golden Mines of Gippsland, Victoria. Describes a new field in the vicinity of the Bemm River, giving plan of mines and illustration of workings. 1300 w. Aust Min Stand—March 18, 1897. No. 12653. 30 cts.

The Reefs of the Sheep-Station Creek (Vic.). General remarks descriptive of some of the typical mines of this region. 1800 w. Aust Min Stand—March 25, 1897. No. 12844. 30 cts.

IRON AND STEEL.

AMMONIA.

The Agricultural Value of Sulphate of Ammonia from Blast-Furnaces. F. J. R. Carulla. Read at Iron and Steel Inst. The value of this product as a fertilizer for agricultural purposes, and the causes of the seeming decrease in money value. 2300 w. Gas Wld—May 15, 1897. No. 13088. 30 cts.

BESSEMER Process.

The Invention of the Bessemer Process. Joseph D. Weeks. Portions of the presidential address at the Pittsburg meeting, Feb., 1896, which have historical value. Ill. 3500 w. Trans Am Inst of Min Engs—May, 1897. No. 13171. 45 cts.

Presidential Address of Edward P. Martin, at Annual Meeting of Iron and Steel Institute, London. Interesting retrospect concerning the early history of the Bessemer process, a broad general survey of the present condition of the iron-making industry, with particular notice of the enormous advance in blast-furnace practice, &c. 4500 w. Col Guard—May 14, 1897. No. 13069. 30 cts.

BLAST Furnace.

The Handling of Material at the Blast Furnace. Axel Sahlin. Briefly records some of the most important steps which have been taken to solve this problem, and offers a few suggestions. Ill. 7200 w. Trans Am Inst of Min Eng—May, 1897. No. 13169. 45 cts.

CHARGING.

On Charging Open-Hearth Furnaces by Machinery. Jeremiah Head. Paper read before the Iron and Steel Inst. Illustrated description of charging machines, with discussion of their advantages. 4000 w. Engng—May 14, 1897. No. 13080. 30 cts.

CONVERTER.

The Tropenas Steel Converter. Carl Pixis. Illustrated description of a converter devised for the conversion of phosphoric or hematite pig iron into ingot iron or steel by compressed air at a low pressure. 1200 w. Eng & Min Jour—May 1, 1897. No. 12597. 15 cts.

CRUCIBLES.

On the Permeability of Steel-Melting Crucibles. J. O. Arnold and F. K. Knowles. Read before the Iron and Steel Inst., London. Experiments and results, showing the walls of the crucible form little protection against the absorption of sulphur by the metal inside. Discussion follows. 6000 w. Ir & St Trds Jour—May 15, 1897. No. 13133. 30 cts.

The Manufacture and Care of Crucibles. John A. Walker. Read before the American Foundrymen's Assn. A brief account of crucibles and crucible making, also discussing how they should be cared for, and the causes of failure. 2500 w. Ir Age—May 20, 1897. No. 12961. 15 cts.

CUPOLAS.

See same title under Mechanical Engineering, Shop and Foundry.

FORTIFICATIONS.

Iron Fortifications. Illustrates a system of iron fortifications invented by James Acton Miller of New Haven, Conn. 1500 w. Ir Age—May 20, 1897. No. 12960. 15 cts.

GERMANY.

The Iron Ore Deposits of Germany. A. Kowastch. Calls attention to rapidly approaching exhaustion of many of the oldest mines, and recommends Germany as a market for southern ores. 1500 w. Tradesman—June 1, 1897. No. 13249. 15 cts.

HARDENING of Steel.

The Hardening of Steel. Henry M. Howe. Remarks in the discussion of the paper of Mr. Sauveur on "The Microstructure of Steel and the Current Theory of Hardening." 6400 w. Trans Am Inst of Min Engs—May, 1897. No. 13170. 45 cts.

HEAT TREATMENT.

Notes on the Heat Treatment of Iron and Steel. Harry E. Smith. Considers some of the characteristics which a piece of tool or cast steel can be made to assume by the application of heat. Outlines some of the physical and chemical changes. 3000 w. Eng's Year Book, Univ of Minn—1897. No. 13005. 45 cts.

IRON Trade.

See Economics and Industry, Commerce and Trade.

MAGNETISM.
See Electrical Engineering, Miscellany.

MELTING and Mixtures.
Melting Iron and Control of Mixture. James A. Beckett. Read at the Detroit Convention of the American Foundrymen's Assn. Discusses the melting of iron by the use of the Victor Colliau cupola, and begins the consideration of mixtures in part first. 3500 w. Ir Trd Rev—May 27, 1897. Serial. 1st part. No. 13143. 15 cts.

MICROSCOPE.
Microscopy and Iron Making. (Mikroskopie und Betrieb.) Showing the use of the microscope in investigating blast-furnace work in actual work, with reproductions of micro-photographs. 6000 w. Stahl und Eisen—April 15, 1897. No. 12782. 45 cts.

NICKEL Steel.
Nickel Steel as an Improved Material for Boiler-Shell Plates, Forgings and Other Purposes. The advantages of nickel steel, with tables of comparison. 1000 w. Engng Mech—May, 1897. No. 13023. 30 cts.

OPEN-HEARTH.
Notes on the Practice of the Combined Open-Hearth Process of Messrs. Bertrand and Thiel. E. Bertrand. Describes a series of experimental heats, with general results given in tabulated form, and discusses the work. Discussion follows. Read at Iron and Steel Inst., London. 10000 w. Ir & St Trds Jour—May 15, 1897. No. 13134. 30 cts.

PAINTING Iron.
See Architecture and Building, Construction and Design.

PHOSPHORUS.
Notes on the Determination of Insoluble Phosphorus in Iron-Ores. Charles T. Mixer and Howard W. Dubois. Describes experiments made with the purpose of determining either the total phosphorus or the insoluble phosphorus by itself. 1400 w. Trans Am Inst of Min Engs—May, 1897. No. 13168. 45 cts.

STEAM POWER.
The Economical Development and Use of Steam Power in Iron and Steel Works. E. J. Duff. Read before the West of Scotland Iron and Steel Inst. Considers where improvement may be made in the generation and application of steam power. 900 w. Ir & St Trds Jour—May 1, 1897. Serial. 1st part. No. 12863. 30 cts.

STEEL.
The Import of the Recent Development of Low Steel. (Die Bedeutung und Neuere Entwickelung der Flusseisenerzeugung.) A most valuable paper read before the Düsseldorf convention of the German Association of Iron Manufacturers by Herr Schrodter, with many important tables and diagrams. 20000 w. Stahl und Eisen. May 1, 1897. No. 12783. 45 cts.

STRESSES.
The Effect of Alternate Positive and Negative Stresses on Iron and Steel. Thomas Gray. Experiments made on test pieces of cast-iron, wrought-iron, and mild steel, the results of which are given with autographic diagrams. 1800 w. Trans Am Soc of Mech Engs—Vol. XVIII. May, 1897. No. 13055. 45 cts.

TENSILE Strength.
The relation of Tensile Strength to Composition in Structural Steel. A. C. Cunningham. A brief account of notable investigations made of late years, with the conclusions of Mr. H. H. Campbell, with rule adopted by the author. 1500 w. Pro Am Soc of Civ Engs—May, 1897. No. 13125. 75 cts.

WORKS.
The New Dowlais-Cardiff Iron and Steel Works. Brief history with illustrated description of plant and appliances. 4000 w. Ir & Coal Trds Rev—May, 21, 1897. No. 13160. 30 cts.

YIELD POINT.
The Yield Point of Iron and Steel. Thomas Gray. Describes the diagrams of a few tests bearing on the peculiar behavior of iron and steel as they pass through the yield point. 1600 w. Trans Am Soc of Mech Engs—Vol. XVIII. May, 1897. No. 13056. 45 cts.

MINING.

ANTHRACITE.
Anthracite Mining. Improvements proposed by G. M. Williams, inspector of the 4th Anthracite Dist. A review of old methods, and a plan offered for future workings, which he thinks will result in increased economy and safety. 1800 w. Col Eng—May, 1897. No. 12975. 30 cts.

COMPRESSED Air.
See Mining Purposes, under Mechanical Engineering, Compressed Air.

LAMPS.
Guichot Self-Lighting Safety Lamps. M. Chesneau. From a report to the French fire-damp commission. Experiments made to test two re-lighting safety lamps; an oil lamp with match lighter, and petroleum-spirit lamp with fulminating lighter. Ill. 1100 w. Col Guard—May 21, 1897. No. 13207. 30 cts.

MINE Fire.
The Fire in the Sunday Creek Coal Company's Mine No. 10. Edward H. Coxe and C. H. Thompson. An account of the cause, and manner of fighting a fire. 3200 w. Eng & Min Jour—May 22, 1897. No. 13039. 15 cts.

SUBSIDENCE.
The Subsidence of Railway Tracks and Other Structures Located Over Mine Excavations. John Keay. Explains the system of working mines, quotes legal decisions and principles relating to surface support in this and other countries. Ill. 4000 w. Eng News—May 27, 1897. No. 13136. 15 cts.

VENTILATION.
Alluvial Mines Ventilation. A. Robertson. The manner of working is described and the best means of ventilating. 1200 w. Aust Min Stand—April 8, 1897. No. 12848. 30 cts.

Ventilation of Mines. J. Sharpe. Discusses natural, artificial and mechanical ventilation. 2000 w. Aust Min Stand—April 8, 1897. No. 12846. 30 cts.

MISCELLANY.

ALUMINUM Works.
The Aluminum Works at Foyers. Illus-

trated description of the engineering features. 2800 w. Elec Rev, Lond—May 14, 1897. No. 13085. 30 cts.

ASBESTOS.

Asbestos and Asbestic: With Some Account of the Recent Discovery of the Latter at Danville in Lower Canada. Robert H. Jones. Its nature and historical relations; its adaptations and extensive use; with description of asbestic, &c. Also discussion. 11700 w. Jour Soc of Arts—April 30, 1897. No. 12818. 30 cts.

BORING.

A New System of Boring. (Ueber ein Neues Bohr System.) An account of Fauck's apparatus for deep rock boring. The impact tool is operated at the end of a cord, the blows being given by a specially designed and illustrated mechanism. 1500 w. Zeitschr d Oesterr Ing u Arch Ver—April 9, 1897. No. 12719. 30 cts.

CEMENT.

The Cement Materials of Southwest Arkansas. John C. Branner. Information concerning the chalk and clay-beds, gained by a visit to the localities. Ill. 6200 w. Trans Am Inst of Min Engs—May, 1897. No. 13172. 45 cts.

CHROMITE.

The Chromite-Deposits on Port au Port Bay, Newfoundland. George W. Maynard. The discovery, location and original investigations, with statement of results. 1600 w. Trans Am Inst of Min Engs—May, 1897. No. 13166. 45 cts.

DIAMONDS.

The South African Diamond Mines. William F. Booth. A brief sketch of their history and development, and how the gems are obtained from the clay. Ill. 1400 w. Col Eng—May, 1897. No. 12972. 30 cts.

FLAWS.

The Detection of Flaws by the Schiseophone, (Le Schiséophone.) This is a modification of the microphone by means of which flaws in metal are detected by the modification produced in the sound of tapping as heard in the microphone. 1000 w. Le Génie Moderne—May 1, 1897. No. 12740. 30 cts.

GAS Producer.

Notes on Some Recent Forms of Gas Producer. A. H. Sexton. Jour. of the West of Scotland Iron and Steel Inst. Calling attention to some new forms of producer for which great advantages are claimed. 2000 w. Am Mfr & Ir Wld—May 7, 1897. No. 12655. 15 cts.

MELTING Points.

Relations Between the Melting Points and the Latent Heats of Fusion of the Metals. Joseph W. Richards. A collection of data, pointing out the limits of the relation, with observations. 900 w. Jour Fr Inst—May, 1897. No. 12648. 45 cts.

METAL Mines.

Characteristic American Metal Mines. J. Wyman Jones. Describing the plant of the St. Joseph Lead Company. Ill. 1800 w. Eng Mag—June, 1897. Serial. 1st part. No. 13259. 30 cts.

The Mineral and Metal Production of the United States in 1896. A full and corrected statement of the output of the mines and metallurgical works of the United States for the last year, with their values. 4400 w. Eng & Min Jour—May 29, 1897. No. 13179. 15 cts.

PHOSPHATES.

Phosphates in Tennessee. H. D. Ruhm, Interesting survey of present operation in the new field. 2200 w. Mfrs Rec—May 28, 1897. No. 13132. 15 cts.

SALTPETER.

Our Saltpeter Caves in Time of War. Horace C. Hovey. Describes what was once a vital industry of the United States, though now abandoned, and the importance of these deposits in time of war. 2000 w. Sci Am—May 8, 1897. No. 12642. 15 cts.

TELLURIUM.

The Purification of Crude Tellurium. (Ueber die Reinigung des Rohtellurs.) A review of past and present methods by the director of the Vienna Assay Office. 3500 w. Oesterr Zeitsch f Berg u Hüttenwesen—April 24, 1897. No. 12776. 30 cts.

MUNICIPAL ENGINEERING.

GAS SUPPLY.

ACETYLENE.

Acetylene at the Agricultural Show. (Au Concours Agricole, L'Acétylène.) Describes several portable generators for household production of acetylene gas from calcium carbide. 2000 w. Le Génie Moderne—May 1, 1897. No. 12742. 30 cts.

See also title "Accidents" under Economics and Industry, Labor.

ARTIFICIAL Light.

See Electrical Engineering, Lighting.

BY-PRODUCTS.

Recovery of By-Products from Gas-Purifying Matter. Dr. Auerbach. Read before the Assn. of Rhenish Gas and Water Engineers. Considers the nature of the gas which enters the purifiers, the nature of the mass serving for purification, and the treatment of the purifying matter during use. 1600 w. Am Mfr & Ir Wld—May 14, 1897. No. 12890. 15 cts.

CARBURATION.

The Carburation of Coal Gas. Charles E. Botley and C. F. Botley. Read before the Inst of Gas Engrs. London. A statement of the napthalene difficulty at Hastings, and the method of overcoming it, giving an account of the investigations. Appendix and discussion follow. 16000 w. Gas Wld—May 8, 1897. No. 12990. 30 cts.

COAL GAS.

The Self-Enrichment of Coal Gas. Mr. Shadbolt. Résumé of a former paper and the results of further experiments, followed by discussion. Read at Peterborough, Eng., before Eastern Counties' Gas Mgrs. Assn. 3800 w. Gas Wld—April 24, 1897. No. 12619. 30 cts.

CURBS.

Gasholder Curbs. John P. Leather. Calcu-

lation of strains. 1600 w. Gas Wld—April 24, 1897. Serial. 1st part. No. 12617. 30 cts.

CYANOGEN.

Notes on Cyanogen as a Gas-Works Residual. G. P. Lewis. Read before the Inst. of Gas Engs., London. Considers cyanogen compounds, recovery from crude gas, extraction from spent oxide, &c., with discussion. 10000 w. Gas Wld—May 8, 1897. No. 12989. 30 cts.

FLAME.

The Luminosity of Flame. A. Smithells. Read before the Inst. of Gas Engs., London. States the difficulties relating to the study of flames, the chemical and physical character of soot, how carbon is set free in flames, cause of the glow of the separated carbon, &c. Discussion. 5500 w. Gas Wld—May 8, 1897. No. 12988. 30 cts.

GAS.

A Means of Largely Increasing the Summer Sendout of Gas. J. C. Lord. Read at meeting of Texas Gas and Elec. Light Assn. The writer's experience is given, followed by discussion. 4200 w. Am Gas Lgt Jour—May 10, 1897. No. 12700. 15 cts.

Selling Gas. I. C. Copley. Read at meeting of Western Gas Assn. The writer enumerates the conditions he considers essential, and considers the sale of gas for fuel. Discussion. 9400 w. Pro Age—June 1, 1897. No. 13188. 15 cts.

GAS Engineering.

Inaugural Address before the Institution of Gas Engineers, England. Corbet Woodall. The range and diversity of the lines of gas engineering practice, the progress, &c., with favorable remarks on inclined retorts and carburetted water gas. 6000 w. Gas Wld—May 8, 1897. No. 12987. 30 cts.

Presidential Address of J. T. Jolliffe, before Eastern Counties Gas Managers' Association. Considers temperature effects, coke and ammonia, manufacture, condensation, purification, fittings and incandescent lighting. 4800 w. Gas Wld—April 24, 1897. No. 12618. 30 cts.

GASHOLDERS.

The Influence of Wind on Gasholders. M. Irminger. An account of experiments made by the writer with results. 2600 w. Jour Gas Lgt —May 4, 1897. No. 12850. 30 cts.

GAS Producer.

See Mining and Metallurgy. Miscellany.

GAS Purification.

The use of Lime for Gas Purification. S. Carpenter. An article written for young gas managers. Directions, with explanation of the effect, suggestions pointing out the proper method of using the different agents so as to produce beneficial results. 1600 w. Jour Gas Lgt—April 27, 1897. No. 12663. 30 cts.

GAS Works.

Newcastle-under-Lyme Corporation Gas Works. F. A. Winstanley. Description of works and plant. 1800 w. Gas Eng's Mag—May 10, 1897. No. 13131. 30 cts.

The Amsterdam Gas Works. Henry H. Salomons. Read before the Inst. of Gas Engs., London. Description of the works. 3500 w. Gas Wld—May 8, 1897. No. 12993. 30 cts.

GOVERNORS.

Automatic Gas-Station Governors. Henry O'Connor. Read before the Soc. of Engs., England. Describes the duty which the gas governor is called upon to perform, with the more recent gas governors in use. 7000 w. Jour Gas Lgt—May 4, 1897. No. 12851. 30 cts.

Automatic Gas-Station Governors. The discussion of Mr. O'Connor's paper. 4000 w. Jour Gas Lgt—May 11, 1897. No. 12977. 30 cts.

ILLUMINATION.

See Electrical Engineering—Lighting.

MAINS.

Locating, Determining and Laying of Street Mains and the Distribution of Gas. J. P. Gill. Part first is largely preliminary remarks calling attention to important points. Also considers the survey of the town or city in which it is proposed to build gas works. 3000 w. Am Gas Lgt Jour—May 3, 1897. Serial. 1st part. No. 12602. 15 cents.

MEETING.

North of England Gas Managers' Association. An account of the half-yearly meeting at Newcastle. President's address, abstracts of papers and discussions, &c. 5800 w. Jour, Gas Lgt—April 27, 1897. No. 12664. 30 cts.

OXIDE.

The Value of Spent Oxide. Dr. Auerbach. Summary of paper read at meeting of the Assn. of Mid-Rhenish Gas and Water Engs. Discusses the quality of gas entering the purifier, the conditions of the purifying material, and the treatment of the material during use. 1600 w. Jour Gas Lgt—May 11,1897. No. 12976. 30 cts.

PUBLIC Lighting.

Incandescent Burners for Public Lighting. Summary of report of Thomas H. Nesbit. The data given were collated from replies obtained to a circular letter. 4500 w. Gas Wld—May 22, 1897. No. 13185. 30 cts.

RETORTS.

A Study of Inclined Retorts in Europe. Frederick Egner. Read before the Western Gas Assn. Observations gathered on a trip through England, France, Germany and Austria, made with the object of studying the "Inclined" or "Sloping" retorts. Discussion. 5000 w. Pro Age—June 1, 1897. No. 13190. 15 cts.

REVIVIFICATION.

Revivification of Oxide of Iron in Purifiers. Isaac C. Baxter. Read at meeting of Western Gas Assn. The methods are discussed and the advantages stated. Discussion follows. Ill. 5800 w. Pro Age—June 1, 1897. No. 13187. 15 cts.

SEPARATOR.

An Oil-Tar Separator and Its Results. J. R. Lynn. Read before the Western Gas Assn. Illustrated description of the apparatus used by the Detroit Gas Co.—and the results. Discussion. 5700 w. Pro Age—June 1, 1897. No. 13189. 15 cts.

VIENNA.

Gas-holder and Retort-house of the Vienna

Gas-Works. (Gas Behältergebäude und Ofenhaus der Wiener städt. Gaswerke.) Description and plates of the pretentious architecture of these important works. 2500 w. and 2 plates. Wiener Bauindustrie Zeitung—April 8, 1897. No. 12785. 45 cts.

SEWERAGE.

DRAINAGE.

Karachi Municipal Drainage Scheme. J. Strachan. Plan showing the position of various works connected with this scheme, with report of the work of the sewerage farm. 500 w. Ind Engng—April 3, 1897. Serial. 1st part. No. 12806. 45 cts.

FILTER Beds.

Operation of the Sewage Filter Beds of Brockton, Mass., in 1896. Information abstracted from report of F. Herbert Snow, city engineer. 2300 w. Eng News—May 20, 1897. No. 12995. 15 cts.

SEWER Flushing.

Systems of Sewer Flushing and Suggestions on Flush-Tank Design and Construction. Andrew Rosewater. An analysis of the relative merits of the various methods of flushing sewers, with suggestions as to the construction, operation and care of the flushing devices in general use. 2300 w. Eng News—May 6, 1897. No. 12678. 15 cts.

SEWERS.

Sewer Outlets at Niagara Falls, Ont. Charles H. Mitchell. The novel features are illustrated and described. 1400 w. Eng News—May 13, 1897. No. 12882. 15 cts.

STORM-WATER Sewers.

A Graphical Method for Determining the Capacity of Storm-Water Sewers. Clinton S. Burns. Shows how a graphical diagram may be constructed to afford an easy means of obtaining results from the new formula proposed by W. Santo Crimp and Charles E. Bruges. 1700 w. Engng Jour—May, 1897. No. 13123. 30 cts.

TRADES-Refuse.

West Riding Rivers. The Problem of Trades-Refuse. Editorial giving successful solutions of the liquid trades-refuse problem. The case adduced refers to the woolen trade. 2200 w. Engng—May 7, 1897. No. 12899. 30 cts.

STREETS AND PAVEMENTS.

ASPHALT.

Softening Agents for the Production of Asphalt Cement for Paving and Other Purposes. Clifford Richardson. States the popular fallacies in regard to petroleum residuum, describes petroleum residuum, and gives information and results of experiments. 2000 w. Munic Engng—June, 1897. No. 13197. 30 cts.

IRON Slag.

American Iron-Slag Paving. George W. Hayes. An account of the use of this material on the roads around Lebanon, its wearing qualities, manner of laying, &c. 800 w. Munic Engng—June, 1897. No. 13198. 30 cts.

PAVING Brick.

Report of the Commission on Standard Specifications and Methods of Testing Paving Brick. Edward Orton, Jr. A brief résumé of report previously given, with additional tests and conclusions. 6000 w. Clay Rec—April 29, 1897. No. 12641. 15 cts.

SCOW.

See Marine Engineering.

STREET Cleaning.

How the Streets of Paris are Cleaned. The work of the street cleaning department is described. 2000 w. San Rec—April 30, 1897. No. 12801. 30 cts.

STREET Lighting.

Street Lighting by Electricity. F. J. Warden Stevens. The article is chiefly to show that, as the standard of illumination is increased, electric lighting comes to the fore as the cheapest and most satisfactory. 2000 w. Arch., Lond—April 30, 1897. No. 12809. 30 cts.

SYDNEY, N. S. W.

Hard-Wood Pavements in Sydney, New South Wales. R. W. Richards, in The Surveyor. A short paper with discussion. 4800 w. Ind & East Eng—April 17, 1897. No. 13013. 45 cts.

WOOD Paving.

Hard-Wood Paving. From the London "Standard." Brief account of the growth of this industry, important changes, use of Australian hard woods, &c. 1600 w. Ill Car & Build—May 7, 1897. No. 12917. 30 cts.

California Redwood for Street Pavements. Ernest McCullough. Some account of paving experiments in San Francisco, with description of the use of redwood, manner of preparation and laying. Also remarks on other kinds of pavement. 2200 w. Munic Engng—June, 1897. No. 13199. 30 cts.

WATER SUPPLY.

DAM.

The New Holyoke Water-Power Dam. Sanford E. Thompson. Describes the construction of the present wooden dam, and the repairs that have been necessary, and gives details of the new stone dam, the materials, special tests and contract work. Ill. 7000 w. Eng News—May 13, 1897. No. 12879. 15 cts.

ENGLISH Water Supplies.

Water Supply of English Cities. The water supply of London as compared with other English cities is discussed. 2000 w. Fire and Water—May 22, 1897. No. 13103. 15 cts.

FILTRATION.

Filtration at Lexington, Ky. Decaying matter accumulating in the reservoirs made filtration necessary. A mechanical filter is used with success. The aerating feature is conspicuous. Cost given. 900 w. Fire and Water—May 1, 1897. No. 12616. 15 cents.

ILLINOIS.

The Water Supplies of Illinois. An account of the survey of the waters of this state for the purpose of determining their present sanitary condition, with statement of results. Ill. 2400 w. Fire & Water—May 29, 1897. No. 13177. 15 cents.

LONDON.

The London Water Supply. Dr. Percy Frankland. The advances which have been made in knowledge of the hygienic aspects of potable water, due to the discoveries in the science of bacteriology, with facts regarding the treatment

of the London supply, and its efficiency. Discussion follows. 11000 w. Jour Soc of Arts —May 21, 1897. No. 13182. 30 cts.

NEW YORK.

The Water Supply of New York City. High praise for this metropolitan work, with information concerning the new Jerome Park reservoir. Ill. 2000 w. Sci Am—May 15, 1897. No. 12856. 15 cts.

ONE HUNDRED-FOOT Standard.

The 100-Foot Standard of Length of the Boston Water Works at Chestnut Hill Reservoir. Charles W. Sherman. A brief description with some of the problems which came up, in graduation and testing. Ill. 5000 w. Jour Assn of Engng Soc—April, 1897. No. 13015. 30 cts.

OVERFLOW.

The Arrangements and Dimensions of Overflow Pipes. (Anordnung und Bemessung des Durchmessers der Ueberlaufrohre.) Especially dealing with overflow pipes for water tanks, including cost. 2000 w. Gesundheits Ingenieur —April 30, 1897. No. 12778. 30 cts.

PUMPING.

Pumping Engines for Rotterdam. Illustrates and describes engines recently constructed for the water-works. They are of the surface-condensing triple-expansion type, with three cranks at 120 deg., each piston-rod driving a double acting pressure pump. 1600 w. Eng, Lond—April 13, 1897. Serial. 1st part. No. 12688. 30 cts.

RESERVOIRS.

Reservoirs of Rammed Béton. (Wasserbehalter aus Stampfbéton.) Describing and illustrating a roofed reservoir of béton of about 80,000 gallons capacity, at Aussig in Bohemia. 1200 w. Zeitschr d Oesterr Ing un Arch Ver—April 23, 1897. No. 12723. 30 cts.

The Jerome Park Reservoir. Description with illustrations and interesting information. 2200 w. Fire & Water—May 15, 1897. No. 12931. 15 cts.

The New Distributing Reservoir for the Water-Supply System of Minneapolis. C. H. Kendall. Description and information of the reservoir and filter plant being constructed at this city. 1700 w. Eng's Year Book, Univ of Minn—1897. No. 13012. 45 cts.

The New Reservoir for New York. From the N. Y. Sun. Interesting information in connection with the water supply of the past fifty years, and the new reservoir, which is to cost fully $10,000,000. 1400. Eng—May 8, 1897. No. 12884. 15 cts.

SANITATION.

Sanitary Problems Connected with Municipal Water Supply. W. P. Mason. Presents the dangers arising from insanitary methods, the ignorance of the general public, gives statistics of several noted epidemics and their cost, and an extended discussion of the subject. 7000 w. Jour Fr Inst—May, 1897. No. 12644. 45 cts.

RIVETED Pipe.

The Distortion of Riveted Pipe by Back-Filling. D. D. Clarke. Notes on work near Portland, Ore., with account of tests and results, which may be of service to those investigating the question of the depth of trench permissible for steel water pipe under certain conditions. Tabulated statements of tests. Ill. 2500 w. Pro Am Soc of Civ Engs—May, 1897. No. 13124. 75 cts.

STAND-PIPES.

Leaning Stand-Pipes at Red Oak and Griswold, Ia. W. D. Lovell. Describes the two cases named and the straightening of the first. The second still stands and no further settlement has taken place. 900 w. Eng News—May 13, 1897. No. 12881. 15 cts.

TAPPING.

Making a Thirty-Six-Inch Cut in a Forty-eight-Inch Water Main. An illustrated account of work accomplished by the Smith tapping apparatus. 1000 w. Fire & Water—May 8, 1897. No. 12829. 15 cts.

VALVE.

The Liebenow Water Valve. (Das Liebenowsche Nebenschlussventil.) An auxiliary valve to be used in connection with water meters to prevent the "water hammer" action and reversal of current. Its use shows a marked increase in accuracy of the meters. 3000 w. Zeitsch d Ver Deutscher Ing--April 3, 1897. No. 12702. 30 cts.

VIENNA.

The Works on the Vienna Water Supply. (Die Arbeiten der Wienthal-wasserleitung.) An account of the four great reservoirs and filter plant now under construction, with plate of details of sand filter, and report of discussion. Five articles. 25000 w. Zeitscher d Oesterr Ing u Arch Ver—April 16, 24, 30, and May 7 and 14, 1897. No. 12720. $1.50.

WATER Meters.

Water Meters. Joseph B. Rider. Examples are given aiming to show that a universal meter system is desirable, and stating its advantages. 32000 w. Fire & Water--May 29, 1897. No. 13176. 15 cts.

WATER Towers.

Some Recent Examples of Water Tower Construction. Illustrates and describes three interesting designs, located at Warren, Ill., Dwight, Ill., and Lexington, Ky., respectively. 800 w. Eng News--May 27, 1897. No. 13135. 15 cts.

WATER Works.

St. Paul Water Works. John Caulfield. Historical account, with description of sources of supply, quality of water, plant, &c. Ill. 3000 w. Fire & Water—May 29, 1897. No. 13178. 15 cts.

The New Lake Tunnel and Cribs for the Cleveland, O., Water-Works. C. F. Schulz. Illustrated description of the work begun for securing a water supply untainted by sewage for the city of Cleveland. 3000 w. Eng Rec —May 22, 1897. No. 13083. 15 cts.

The Water-Works at Hollister, Cal. C. E. Grunsky. Illustrated description, calling attention to special features. 1500 w. Eng News—May 6, 1897. No. 12677. 15 cts.

MISCELLANY.

GARBAGE Disposal.

The Vexed Question of Garbage Disposal. Rudolph Hering. Reviewing the various methods, with special attention to that of cremation.

Ill. 2800 w. Eng Mag—June, 1897. No. 13262. 30 cts.

MUNICIPAL Engineering.

Notes on Municipal Engineering Work at Salt Lake City. Details, compiled from drawings and information furnished by the city engineer. Principally details of street work. Ill. 1400 w. Eng News—May 6, 1897. No. 12680. 15 cts.

NEW YORK.

The Municipal Problem and Greater New York. Albert Shaw. Discusses the problem of municipal government, reviews the past history of New York and Brooklyn, and discusses the charter for Greater New York. Reference is made to the simplicity of the fundamental machinery of cities in other lands. 11500 w. Atlantic M—June, 1897. No. 12999. 45 cts.

REFUSE.

Electric Supply and the Destruction of Town Refuse. F. J. Warden-Stevens. Describes the usual form of destructor, and its working, showing how much heat may be obtained per pound of refuse, and how far the heat from the destructor is usable for electric supply. 2800 w. Arch, Lond—May 14, 1897. No. 13101. 30 cts.

REFUSE Destructor.

The Morse-Boulger Garbage and Refuse Destructor. Description with a statement of the new principles claimed for the system. 1000 w. Eng Rec—May 15, 1897. No. 12949. 15 cts.

STERILIZATION.

The Sterilization of Liquids in Bulk under High Pressure. (Stérilization des Liquides en Grandes Masses sous Hautes Pressions.) The Kuhn process, by means of which all decomposition or cooking of the liquid is avoided and fermentation may be arrested at any stage. 1200 w. La Revue Technique—April 10, 1897. No. 12733. 45 cts.

RAILROAD AFFAIRS.

NEW CONSTRUCTION.

FAR EAST.

From London to the Far East by Railway. Reviews the various schemes proposed for building railways connecting the distant parts of the world, and makes remarks on the probable effect of the Trans Siberian railway. 1800 w. Engng May 14, 1897. No. 13078. 30 cts.

INDIA.

The Railway to India. C. E. D. Black. Discusses the importance, the political aspect, and physical obstructions; touching also the commercial advantages. Discussion follows. 6000 w. Jour Soc of Arts—May 7, 1897. No. 12916. 30 cts.

LANARKSHIRE.

Lanarkshire and Dumbartonshire Railway. Illustrated description of the new railway connecting the iron and coal district of Mid-Lanarkshire with the numerous shipbuilding and engineering works of the Clyde. 3500 w. Engng—May 7, 1897. Serial. 1st part. No. 12897. 30 cts.

LIGHT Railways.

Light Railways for the Cape. A summary of information collected by a commission appointed by the government, to visit and report upon the Continental and Irish systems. Favors the construction of light railways, by contract and by private companies. 1500 w. Engng—April 30, 1897. No. 12685. 30 cts.

MOUNTAIN Railway.

The Darjeeling Himalayan Railway. Illustrated brief description of an interesting construction, showing several complete loops, zigzags, and curves. 900 w. Engng—April 30, 1897. No. 12682. 30 cts.

TUNNEL.

See same title under Civil Engineering, Miscellany.

MAINTENANCE OF EQUIPMENT.

AXLE Boxes.

The Defects of Existing Axle Boxes. (Mängel der Jetzigen Achsbüchsen.) Discussion of the axle boxes of the Prussian State Railways, with interesting data about breakages, wear and lubrication. 7500 w. Glaser's Annalen—April 15, 1897. No. 12743. 45 cts.

BRAKES.

Inside Brakes for Passenger Cars. Gives the reason for adopting this plan of construction on the Canadian Pacific. 900 w. Ry Age—May 14, 1897. No. 12930. 15 cts.

The Air Brake. R. A. Parke. History of the air brake, and its evolution from straight air to automatic, from automatic to quick action, and from quick action to the modern high-speed brake, with sectional views. 5400 w. Ry Mag—April, 1897. No. 12835. 30 cts.

CABOOSE.

Caboose Car. Lake Shore and Michigan Southern Railway. Describes some new caboose cars recently built by this road, from the designs and drawings of A. M. Waitt. Ill. 900 w. Am Eng & R R Jour—June, 1897. No. 13236. 30 cts.

COAL Car.

Hopper Coal Car. Chesapeake and Ohio Railway. Illustrated description of a car of 80,000 lbs. capacity, with dimensions. 1400 w. R R Car Jour—May, 1897. No. 12823. 15 cts.

ICE Car.

Ice Car. Chicago & Northwestern Railway. Illustrated description of cars designed for this special service, but also adapted to carrying grain or coal. 600 w, Am Eng & R R Jour—June, 1897. No. 13233. 30 cts.

JAPAN.

Railways and Locomotive Building in Japan. (Ejsenbahnen und Lokomotivbau in Japan.) A very fully illustrated article showing the styles and builders of locomotives shipped to Japan from Europe and America since 1871 with an account of those of native make. A most valuable article. 8000 w. Zeitsch d Ver Deutscher Ing—April 24, 1897. No. 12708. 30 cts.

LIGHTING.

Railway-Carriage Lighting. Herr H. Gerdes, in Journal für Gasbeleuchtung. Extracts giving use, cost, &c., of Pintsch gas, electricity, and acetylene. 1800 w. Gas Wld—May 1, 1897. No. 12803. 30 cts.

LOCOMOTIVE.

Express Compound Locomotive with Auxiliary Gear. Illustrated description of compound locomotive with a single pair of driving wheels, and with various constructive peculiarities. To be used on the Bavarian State Railway. 4000 w. Engng—May 21, 1897. No. 13154. 30 cts.

Compound Locomotives on the London and Northwestern Railway. Gives particulars of two experiments from the investigations made by F. W. Webb, of the performance of compound goods engines. Data supplied by the indicator and the tractometer. Also editorial. 2300 w. Eng, Lond—May 7, 1897. No. 12907. 30 cts.

Locomotive Building in Japan. Engravings illustrating the most recent achievements in the way of locomotive building by the Japanese, with dimensions and details. 1100 w. Sci Am Sup—May 22, 1897. No. 12968. 15 cts.

Ten Wheel Compound Passenger Locomotive —Northern Pacific Railway. General dimensions and description of the third design of some noteworthy locomotives recently built. Ill. 800 w. Am Eng & R R Jour—June, 1897. No. 13232. 30 cts.

The Heilmann Electric Locomotive. (Die Elektrisch Lokomotiv von Heilmann.) Detailed description of the 115 ton electric locomotive, of which design two have just been completed for the Western Railway of France. 3500 w. and 1 plate. Glaser's Annalen—April 15, 1897. No. 12744. 45 cts.

See also Street and Electric Railways.

LOCOMOTIVE Weight.

Distribution of Axle Loads. (Das Diagramm der Achselbelastungen.) Diagrams showing the distribution of the weight of a locomotive for a variety of arrangements of axles and equalizing levers. 5000 w. Glaser's Annalen—May 1, 1897. No. 12746. 45 cts.

LUBRICATION.

Lubrication of Locomotive Cylinders. Brief discussion of practice and results, with suggestions. 1300 w. Am Eng & R R Jour—June, 1897. No. 13238. 30 cts.

Economy in Engine Oil. Abstract of discussion at the April meeting of the New England R. R. Club. 2000 w. R R Gaz.—May 21, 1897. No. 12983. 15 cts.

Oiling Cylinders. Clinton B. Conger. Reviews past methods, and changes made in oiling valves and cylinders of locomotives, giving facts and observations from the writer's experience. 1800 w. Loc Engng—May, 1897. No. 12673. 30 cts.

PETROLEUM.

Petroleum Fuel on the Russian Locomotives (Chauffage au Pétrole des Locomotives des Chemins de Fer Russe.) Review of Russian official report, showing large increase in the use of petroleum refuse for locomotive firing. 3500 w. La Revue Technique—25 April, 1897. No. 12737. 45 cts.

PRIVATE Cars.

Modern Private Cars. Duane Doty. Illustrated description of the "Pioneer" and "Virginia." 1900 w. R R Car Jour—May, 1897. No. 12824. 15 cts.

Proposed Plans for Presidential Car. Illustrations of plans proposed by E. D. Nelson and Thomas Anderson, with editorial, and an article from the "Railway Agent" in criticism of the project, and other articles bearing on this subject. 3300 w. R R Car Jour—May, 1897. No. 12825. 15 cts.

RAILWAY Car.

The Queen's Railway Train. Interesting description of the particular carriage by which the Queen travels northward. 1200 w. Ill Car & Build—May 21, 1897. No. 13224. 30 cts.

RAILWAY Engineering.

Railway Engineering. Cecil B. Smith. The first of a series of papers to appear later in book form. The papers will deal chiefly with location, construction and maintenance. 3400 w. Can Eng—May, 1897. Serial. 1st part. No. 12830. 15 cts.

REPAIRS.

The Cost of Locomotive Repairs and the Efficiency of Machine Tools in Railroad Shops. William Forsyth. Read before the Western Railway Club. Considers the saving that can be made by the increased capacity of old tools, and by the use of more efficient new tools. 3000 w. R R Gaz—May 14, 1897. No. 12894. 15 cts.

SPEED Indicator.

The Klose Speed Indicator. (Die Geschwindigkeitsmesser, System Klose.) An automatic recording speed indicator for locomotives which has given good results on the Northeastern Railway of Switzerland. 3000 w. Schweizerische Bauzeitung—April 24, 1897. No. 12750. 30 cts.

MAINTENANCE OF WAY.

BRIDGES.

Double-Track Swing Bridge Across the Calumet River—Chicago, Lake Shore and Eastern Railway. Illustrated description. 600 w. R R Gaz—May 7, 1897. No. 12669. 15 cts.

Swedish Railway Bridges Near the Arctic Circle. Illustrated description of bridges on a Swedish railway which is the most northerly in the world. 500 w. Eng News—June 3, 1897. No. 13253. 15 cts.

See also Civil Engineering, Bridges.

FLOODS.

Damage by the March Floods on the P. C. C. & St. L. Illustrated description of the damages on various branches of this American road. 1100 w. R R Gaz—May 14, 1897. No. 12896. 15 cts.

RAIL Joints.

The Joints of Rails. (Les Joints des Rails.) A comparison between French and Austrian practice. 3500 w. La Revue Technique—April 10, 1897. No. 12730. 45 cts.

TRACK.

Notes on Track. W. M. Cramp. Part first is introductory to a study of the proper construction and efficient maintenance of railroad track. 3000 w. Ry Rev—May 8, 1897. Serial. 1st part. No. 12843. 15 cents.

TRACK Elevation.

Track Elevation in Chicago. A general survey of the situation, with special reference to the Sixteenth Street crossing. Ill. 3400 w. Ry Age—May 28, 1897. No. 13231. 15 cts.

TRACK Improvement.

Second Track Construction and Improvement of Line and Grade from Madison to Baraboo, Wis.; Chi. & N. W. Ry. H. W. Battin. Illustrated detailed description of the work. 3500 w. Eng News—June 3, 1897. No. 13254. 15 cts.

TURNTABLE.

Locomotive Turntable Operated by Electric Motor. Illustrated description of the manner of applying an electric motor to the turntable at the West Milwaukee roundhouse of the Chicago, Milwaukee & St. Paul Railway. 800 w. Am Eng & RR Jour—June, 1897. No. 13235. 30 cts.

The Greenleaf Center-bearing Turntable. Illustrated description of turntable operated by compressed air. 1800 w. Eng News—May 13, 1897. No. 12883. 15 cts.

SIGNALING.

AUDIBLE Signal.

Boult's Audible Signal. Describes the construction and operation of an electric signalling device invented by W. S. Boult. 2700 w. RR Gaz—May 21, 1897. No. 12985. 15 cts.

BLOCK System.

Electric Block System. (Ueber Elektrische Block Anlagen.) Paper before the German Railway Society by Herr Nitschmann, describing a system including indicators by which the condition of the switches and signals is constantly in view. 5000 w. Glaser's Annalen—May 1. 1897. No. 12745. 45 cts.

INTERLOCKING.

Dolton Interlocking Plant. An illustrated description of an important plant now being built. 800 w. RR Gaz—May 28, 1897. No. 13146. 15 cts.

TERMINALS AND YARDS.

FREIGHT Terminals.

New Freight Terminals at East St. Louis—Cleveland, Cincinnati, Chicago & St. Louis Railway. Description, with general view and plans, of the new freight houses built to replace those destroyed by the cyclone of 1896. 1300 w. RR Gaz—May 7, 1897. No. 12668. 15 cts.

STATIONS.

Railroad Terminal Stations. Discusses the requirements of freight and passenger terminal stations. 2200 w. Lord's Mag—Feb., 1897. No. 12841. 15 cts.

TERMINALS.

The Proposed Improvement of the Erie Railroad Company's Terminal in Jersey City. A statement of the difficulties to be overcome, with illustrated description of a proposed method. 1600 w. RR Gaz—April 23, 1897. No. 12303. 15 cts.

TRANSPORTATION.

EARNINGS.

Railroad Earnings Show Trifling Gains. Report of April earnings, with classified tables. 3000 w. Bradstreet's—May 15, 1897. No. 12886. 15 cts.

The Quarter's Gross and Net Railway Earnings. Tabulated statements showing the tendencies of earnings of the various groups of roads for the three months of 1897 as compared with the corresponding period and entire year of 1896. 2300 w. Bradstreet's—May 22, 1897. No. 13044. 15 cts.

EMPLOYEE.

Employer and Employee. E. T. Jeffery. Address before the Y. M. C. A. of the Denver & Rio Grande. Extract. 1700 w. Ry Age—May 14, 1897. No. 12928. 15 cts.

INTERCHANGE.

Suggestions for the Revision of the M. C. B. Code of Rules. George S. Hodgins. Suggested modifications by the writer and editor. 3500 w. R R Car Jour—May, 1897. No. 12822. 15 cts.

INTERSTATE Commerce.

See Economics and Industry, Governmental Control.

MILK Rate.

The Milk Rate Decision. An abstract of the report recently issued by the Interstate Commerce Commission on rates for the transportation of milk to New York City, with editorial. 2800 w. R R Gaz—May 7, 1897. No. 12667. 15 cts.

RAILROAD Accounting.

The Physical Aspect in Railroad Accounting. Thomas F. Woodlock. Maintaining that railroad reports should show character and composition of business, and circumstances surrounding its handling. 3300 w. Eng Mag—June, 1897. No. 13257. 30 cts.

RATES.

Another Supreme Court Decision. Editorial comment on the decision that the Interstate Commerce Commission has no power to prescribe rates. 1400 w. R R Gaz—May 28, 1897. No. 13148. 15 cts.

Maximum Railway Rates. Review of a work issued by Messrs. Butterworth & Co., London on the law respecting the maximum charges for the carriage of goods by railway. 2700 w. Trans—April 23, 1897. No. 12607. 30 cts.

RATING.

Tonnage Rating of Locomotives. The method of determining the capacity of locomotives of the Southern Pacific. 1700 w. Ry Age—May 21, 1897. No. 13112. 15 cts.

TRAFFIC.

The Reorganization of the Traffic Associations. Editorial on the new agreements in process of adoption by the various associations, for the purpose of continuing all of their functions which are not contrary to law as expressed in the recent Supreme Court decision. 1100 w. R R Gaz—May 7, 1897. No. 12670. 15 cts.

Traffic Associations and the Law. A summary of the opinions of various courts on the legality of association agreements. 1800 w. Ry Age—May 7, 1897. No. 12827. 15 cts.

Traffic Statistics from Germany and Hungary. Report of railroad passenger- and freight-traffic, with comparison with American rates. 1000 w. R R Gaz—May 21, 1897. No. 12986. 15 cts.

TRAIN RULES.

C., N. O. & T. P. Train Rules. Information in reference to the revised edition of the book of rules for employees in the transportation department of this road. 2000 w. R R Gaz—May 28, 1897. No. 13145. 15 cts.

TRAIN SERVICE.

The May Train Services. Charles Rous-Marten. New departures of the British railway companies. 1200 w. Eng, Lond—May 7, 1897. No. 12905. 30 cts.

TRANS-MISSOURI.

See Economics and Industry, Governmental Control.

MISCELLANY.

ACCIDENTS.

Train Accidents in the United States in April. A detailed list of the more important accidents, with classified summary and comments. 2700 w. R R Gaz—May 28, 1897. No. 13147. 15 cts.

BRITISH Railways.

British Railway Enterprise. Part first gives an idea of British railway management and construction, with illustrations of equipment. 1400 w. Can Eng—May, 1897. Serial. 1st part. No. 12831. 15 cts.

CHINA.

Railroading in China. R. Van Bergen. Interesting information of railroading prospects of this country, with the difficulties and obstacles to be met, and stating that there is no probability of Americans obtaining concessions for building railroads. 1500 w. R R Gaz—May 14, 1897. No. 12895. 15 cts.

ECONOMIES.

Recent Railway Economies. E. E. Woodman. Lecture before the Soc. of Engs. Calls attention to the extensive application of Bessemer metal to the improvement of railways, and the economies in consequence, increase of capacity of cars, growth of engines, &c. 6400 w. Eng's Year Book, Univ of Minn—1897. No. 13007. 45 cts.

ELECTRIC Traction.

Electric Traction Under Steam-Railway Conditions. Charles Henry Davis. Comparing in detail electric and steam systems of installation and operation. 6200 w. Eng Mag—June, 1897. Serial. 1st. part. No. 13260. 30 cts.

FLORIDA.

Florida's Railway Bill. A law to discourage railway investment in the state of Florida, also editorial. 3000 w. Ry Age—May 14, 1897. No. 12929. 15 cts.

NATAL.

The Remarkable Railway Year in Natal. An account of the marvelous earnings of the government railways as given in their report and from interview with Mr. David Hunter, the general manager. 1500 w. Trans—April 30, 1897. No. 12808. 30 cts.

RAILWAYS.

Railways of the World. A review of the last seventy-two years. 1800 w. Sci Am Sup—May 22, 1897. No. 12969. 15 cts.

The People and Their Railways. E. T. Jeffery. An address before the annual convention of the interstate commerce commission and the boards of state railway commissioners held in St. Louis. 9500 w. Ry Age—May 21, 1897. No. 13113. 15 cts.

The Story of the Railway. The First Tracks. Early Locomotives. First of a series of articles to describe and illustrate the development of the railway. 3300 w. Ry Mag—April, 1897. Serial. 1st part. No. 12838. 30 cts.

RELIEF Departments.

Railway Relief Departments. Reviews information on this subject as presented by Mr. Emory R. Johnson, and published as Bulletin No. 8 of the Dept. of Labor, at Washington, with comments. 4000 w. Eng News—June 3, 1897. No. 13255. 15 cts.

RESISTANCES.

Train Resistances. M. Barbier, in the April issue of the Revue Générale des Chemins de Fer. Discussing the question of train resistances at high speeds. The paper is considered a valuable contribution to this subject. 2800 w. R R Gaz—May 21, 1897. No. 12981. 15 cts.

TELEGRAPH.

See same title under Electrical Engineering, Telegraphy and Telephony.

TUNNEL.

See Civil Engineering, Miscellany.

VIBRATION.

The Vibration of Railway Carriages. A. Rudolff. Brief account of tests made by the author, the observations being confined to carriages running on a well-kept road, properly coupled, uninfluenced by neighboring carriages, and situated in the center of the train. 600 w. Prac Eng—April 30, 1897. No. 12816. 30 cts.

STREET AND ELECTRIC RAILWAYS.

ACCUMULATORS.

Traction by Accumulators. An abstract of an article published in the Elektrotechnische Anzeiger, describing some experiments made with a tramcar propelled by accumulators. Ill. 1300 w. Elec Rev, Lond—May 14, 1897. No. 13086. 30 cts.

AMERICAN Practice.

Recent American Practice in Electric Railways. Louis Bell. Part first is confined to the general design and construction of power stations. Ill. 3300 w. Ry Wld—May, 1897. Serial. 1st part. No. 12939. 30 cts.

BROOKLYN.

The General Passenger Department of the Brooklyn Heights Railroad Company. H. Milton Kennedy. Ideas on methods of advertising and other means of increasing the business of street railways. Ill. 2700 w. St Ry Jour—June, 1897. No. 13192. 45 cts.

BUDAPEST.

The Underground Railway at Budapest. (Die elektrische Untergrund bahn zu Budapest.) A very complete illustrated account of the roadway and power plant of this pioneer electric underground road. Two articles. 5000 w. Schweiz-

erische Bauzeitung. April 10 and 17, 1897. No. 12748. 60 cts.

LOCOMOTIVE.

Compressed-Air Locomotive for the Manhattan Elevated Railroad. Brief illustrated description. 350 w. Am Mach—May 6, 1897. No. 12660. 15 cts.

The Hardie Compressed-Air Locomotive for the Manhattan Elevated Railroad. Illustrated description. 800 w. RR Gaz—May 21, 1897. No. 12982. 15 cts.

Electric Locomotives. J. J. Swann. Deals principally with elevated and suburban traffic. 1500 w. Sib Jour of Engng—May, 1897. No. 12962. 30 cts.

PAINTING.

Repainting Old Cars. Charles Koons. Hints and directions for the work, with introductory remarks. 2800 w. St Ry Rev—May 15, 1897. Serial. 1st part. No. 12957. 30 cts.

POWER House.

The Largest Electric Plant in the Country. Illustrated description of Power House No. 2 of the Chicago city railway. 1300 w. Power —June, 1897. No. 13155. 15 cts.

RAILS.

Continuous Rails in Unpaved Streets. Illustrations of continuous rails laid in unpaved streets, with description of construction and report of wear. 700 w. St Ry Rev—May 15, 1897. No. 12955. 30 cts.

RAPID Transit.

Electricity or Steam in Rapid Transit—Which? George Moffat. Concludes that the roads will undoubtedly be driven to use electric motors. 2000 w. Am Eng & RR Jour—June, 1897. No. 13239. 30 cts.

SAFETY Device.

Improved Safety Device for Electric Circuits. Lewis G. Rowand. Describes the writer's method of reducing the element of danger arising from this source, giving different applications of the device to meet the requirements of electric trolley circuits. Ill. 1700 w. Jour Fr Inst—May, 1897. No. 12645. 45 cts.

SPLICING.

Splicing Small Cars. W. H. Pelton. Illustrated description of the forming of one 32-ft. car from two 16 ft. cars. 1100 w. St Ry Rev —May 15, 1897. No. 12959. 30 cts.

TESTING Motors.

Some Methods of Testing Motors. Frank B. Porter. Gives some of the most useful tests that are ordinarily used by electrical engineers, and can be easily applied to the equipment of street railway motors. Ill. 1800 w. St Ry Jour—June, 1897. No. 13194. 45 cts.

THIRD Rail.

The Third-Rail Equipment of the N. Y., N. H. & H. Railroad Between New Britain and Hartford, Conn. Illustrated description of a section formerly operated by steam and recently equipped for electric traction, the third rail system being used. 1800 w. Elec Eng—May 19, 1897. No. 12937. 15 cts.

THREE-WIRE System.

Improvements in the Three-wire System. Truman Hibbard. Reviews numerous patents since 1880, and the advantages gained. 4000 w. Eng's Year Book, Univ of Minn—1897. No. 13006. 45 cts.

TRACTION.

Tramway Traction. A review and criticism of the report of committee of the Corporation Tramways of Sheffield, Eng., after a trip including the principal towns of England and the Continent where different systems of tramway traction were in operation. 3500 w. Eng, Lond—May 14, 1897. No. 13071. 30 cts.

See also "Electric Traction," above.

TRAMWAYS.

The Generation of Electrical Energy for Tramways. J. S. Raworth. The object of the paper is to show that a suitable and paying price for the supply of electric energy for tramway purposes, under reasonably favorable conditions, is one penny per unit and that the said supply will reduce the cost of the lighting current by an amount which, though small, is definite. 2800 w. Elect'n—April 30, 1897. No. 12814. 30 cts.

The Huddersfield Tramways and the Municipalization of Tramways. J. Pogson. Historical account of these tramways, with short discussion. 3300 w. Elec Rev, Lond—April 23, 1897. No. 12601. 30 cts.

TRANSPORTATION.

The Progress of Transportation Improvements in Vienna in 1896. (Ueber den Fortschritt der Verkehrsaulagen in Wien in Jahre 1896.) Including a review of the street improvements, the elevated railway, and the river and canal improvements. Two articles, 3500 w. Zeitschr d Oesterr Ing u Arch Ver—May 7, 1897. No. 12728. 60 cts.

TROLLEY Car.

The Trolley Car After a Day's Run, and Its Repairs. Daniel O'Mahoney. An account of the inspection and repairs, the usual difficulties to be overcome, and the improvements made. 2000 w. Elec Eng—June 2, 1897. No. 13240. 15 cts.

UNDERGROUND Railways.

Deep Tunnel Railways for London. Editorial discussion of some of the schemes for the solution of the transit difficulties. 1800 w. Engng—April 9, 1897. No. 12228. 30 cts.

UNITED STATES.

The Financial Results of Cable and Electric Railway Operation in the United States. Part first gives a broad view of the combined street railway systems of New York, Massachusetts, and Pennsylvania. Later papers will discuss the results of individual street railway systems. 4000 w. St Ry Jour—April, 1897. Serial. 1st part. No. 12073. 45 cents.

WHEELS.

A Comparison of American and European Wheel Practice, with Notes on General Condition of Service, P. H. Griffin. The results obtained from chilled iron- and steel-tired wheels, the advantages of each, the difficulties in electric wheel service, &c. 3500 w. St Ry Jour—April, 1897. No. 12074. 45 cts.

WIRE Tension.

An Important Trolley Question. (Brennende Bahn-Fragen.) A discussion of the great tensional strains upon the trolley wires, due to changes of temperature. 1500 w. Deutsche Zeitschr für Elektrotechnik—March, 1897. No. 12456. 30 cts.

COMMENT & CRITICISM

The Creep of Rails.

THE April number of THE ENGINEERING MAGAZINE contains some extracts from a paper on "The Creep of Rails," read before the Austrian Society of Engineers.

The *résumé* of the paper, says: "In most of the roads investigated the creep was in the direction of the travel of trains and also down grades, as might be expected."

The first statement—that the creep is in the direction of the movement of trains—is not a clear expression of fact. If this be the case, then there would be no creep of the rails on a railway where the traffic was equal in either direction. As the writer happened to be an engineer on maintenance of way for about seven years, on a railway with traffic conditions that were about equal in either direction, and for a period of twelve years made a close study of evidences of creeping rails, he cannot but express his opinion that while the movement of trains upon a track may facilitate the creeping, it is not the cause; this must be looked for elsewhere.

The creep is evidently in the direction of the least resistance.

The movement of a rail under a moving load is a retroaction, inasmuch as the rail under its train-load will come down to a firm bearing, and, when relieved, will again take its normal bearing, or position, thus causing a slight deflection with each moving load it carries. If a rail in use be overturned, the tie-bearing scars will generally show a bearing mark on the rail that is somewhat wider than the tie upon which that part of the rail rested; excepting upon a grade these marks will give no evidence of creeping. There is a slight and constant deflection of rails under moving trains which is often quite perceptible, noticeably so if one will closely examine the track just in advance of a coming train. How much of this movement contributes to the creep? Very little of it, if any.

When a track is re-surfaced, it is raised an inch or more, and, no matter how well the tamping is done, there will be more or less yielding of the track under moving train-loads, after the surfacing work is completed, until the disturbed ballast bearing is again brought to compactness. This resurfacing of the track, the action of the elements, the traffic on the track, all combine to make constant changes in the general elevation of the track, producing a constant subsidence movement. In this combination of conditions the evidences of the creep in rails will be found. The elements are the cause, the traffic is the agitator, and the rails are the victims.

The greatest expansion of track of which the writer is cognizant occurred on a level track, at a bridge approach, in a valley nearly one mile wide, when some thirty cross-ties were lifted entirely from the ground and bridge-stringers. Was the sole cause of this lifting of the track the extreme heat of an August day? Were there ulterior causes affecting this stretch of level track that had more to do with it than the sun? If so, let us examine the two ridges forming the sides of the valley.

Both of the ridges were crossed through heavy cuts, and many years had elapsed since these cuts were excavated and the track laid through them. Since the track was first laid, these cuts had been treated as all railway cuts usually are; the rains and melted snow, supplemented by frost action, had sloughed off the embankment slopes, undermined the track in places, and washed away the gravel ballast, and the track had as often been repaired and put into excellent condition by the track force. Each time a large quantity of material that had been deposited in the ditches upon either side of the track within the confines of the cut was carried out. This had been done so often that the elevation of

the track at the apex of the ridge, and the distance along the face of the rails from the level track in the valley, up the ascent, to the apex of the ridge, was less than when the track was first laid. The deficiency in elevation was apparent from an examination of the original profile compared with a re-survey of the line made many years after the road was completed. While the track had apparently hung in place at the top of the ridge, as a rope would hang over a log, the traffic of the road had gradually rolled the excess in length of rails down the descent, and the level track in the valley had received it. The hot August sun had simply concentrated it.

If railway cuts were more generally subsoil-drained, with good drain tile, there would be less mystery in the creep of rails, so far as grades are concerned; yet the subsidence of the railway embankment is another vital condition affecting rail movement.

The greatest evidence of rail movement is found at the intersection of two railways, where the grade crossing must be continually tinkered to keep it in line with both tracks.

Occasionally it is necessary to shorten a rail on one side and interpose a longer one upon the other side to hold the thing in true alignment.

This trouble with railway crossings the writer has often met with at single crossing, on long stretches of track in the rural districts; and, singular to relate, in Chicago at the stockyards crossing, where there were more than a dozen crossings in one place, he does not recall an instance in seven years when any one of them was ever forced or thrown out of line by the creep of rails; they were worn to pieces in place, by the heavy and constant traffic passing over them.

Evidently the creeping of rails is a local matter; the whole line of track does not creep bodily in one direction, as some writers would have us believe. The creep can be attributed entirely to local conditions, aided by several natural causes.

W. J. GOODHUE.

White Hill, Mohave Co., Arizona, April, 1897.

The Efficiency of Built Beams.

I have read your review of my paper on Built Beams, in your May issue, and I note the question in regard to the solitary case where an efficiency of 108.5 came out. This was not a misprint. In spite of the method of providing check pieces, differences would always be found in the strength of the different sticks cut from the same board. Usually these differences were small, but I have known them to be as much as 30 per cent. Every experimenter on timber has found the same thing. From this it seems reasonable to believe that, in the case referred to, one of the sticks, owing to variation in structure of the material in the four quarters of the beam, was considerably stronger than the check pieces, and that this stronger piece was on the tension side of the built beam, and hence gave the efficiency as 108.5. Such efficiency, was of course, rather apparent than real, but it seems best to give it, as the result was obtained in exactly the same way as the others.

I have now under way a lot more experiments on the same subject, and hope that these may clear up, at least to some extent, the very question you open.

At best, the subject is a difficult one to experiment upon with great accuracy, and I am omitting no means of getting out the most reliable results I am able to obtain, with careful study of all the details.

EDGAR KIDWELL.

Houghton, Mich., May, 1897.

A Correction.

A typographical error, creeping into Mr. A. A. Cary's article on "The Cure for Corrosion and Scale from Boiler Waters" in the May issue of THE ENGINEERING MAGAZINE, makes the instructions for preparing a standard solution of hard water (p. 232) read: "Dissolve 1.11 grains of pure fused calcium chlorid," etc., when the text should read: "Dissolve 1.11 grams of pure fused calcium chlorid."

The error, while not a large one typographically, is of course very important chemically as 1.11 grams is equal to about 17 grains.

BOOKS OF THE MONTH

Derr, Wm. L. Block-Signal Operation. A Practical Manual. D. Van Nostrand. New York. Cloth, $1.50.

Except in one particular, originality is disclaimed by the author, who states his purpose to be the presentation of the latest American and European practice in block-signal operation. The exception, however, appears to be an important one, and is a description and explanation of a method of single-track blocking comprised in Chapter X of the treatise. The author expresses full confidence that this method "will insure the holding, at the proper passing sidings, of trains to be met by opposing trains." The descriptions of apparatus employed are, for the most part, general, details being described only when thought necessary to a proper understanding of the operating rules. The assistance of a long list of prominent railway officials and engineers in supplying information is acknowledged in the author's preface. The whole forms a comprehensive review of methods, apparatus, and rules employed in present practice, illustrated by diagrams.

Greene, Thomas L. Corporation Finance. A Study of the Principles and Methods of the Management of the Finances of Corporations in the United States; with Special Reference to the Valuation of Corporation Securities. G. P. Putnam's Sons. New York. 1897. Cloth, $1.25.

The purpose of this treatise is plainly the extension of popular information upon the subject of corporation financiering, the reasons which underlie the policy pursued in the United States with reference to corporations, and the results of such policy. The author is an auditor of one of the largest trust companies in the country, and, as such, is an authority upon the subject upon which he writes. While thus adapted to the wants of the general public, the treatise is well adapted to use as a text-book in educational institutions, and even the legal profession might find in it valuable hints to be utilized in the organization and administration of corporate affairs.

Baker, M. N. The Manual of American Water Works, 1897. *The Engineering News* Publishing Company. New York. 1897. Cloth, $3.

The author (who is the associate editor of *The Engineering News*) has herein compiled from special returns the history and descriptions of the source and mode of water-supply-pumps, reservoirs, standpipes, distribution systems, pressures, consumption, revenue and expenses, cost, debt, and sinking fund, and much other practical and statistical information relating to the water works of the United States and Canada, with summaries for each State and group of States, and water rates charged in more than 1,250 cities and towns. This is the fourth issue of this annual, and, in addition to what we have above enumerated, the book comprises in its introduction an interesting essay upon "Modern Tendencies in Water Works Practice," and tabulated statements of statistical value. The division between public and private ownership in each State, and changes from public to private ownership and the reverse, are also noted.

Dixon, D. B. The Mechanical Arts Simplified. A Comprehensive Treatise on Electricity, Hydraulics, The Indicator, Ice-Making, etc. Laird & Lee. Chicago, 1867. Cloth, $2.50.

While this volume of 497 octavo pages may fairly be styled "comprehensive" in the number of subjects treated, it is scarcely so in its method of their treatment. Besides the topics named on the title page, those included by the abbreviation, etc., are numerous, diverging into architecture, steam engineering, machine-building, boiler-making, and stone, iron, and woodworking. The book (which has been revised and supplied with a new appendix for the present edition) is intended for service as a work of reference,—in fact, a sort of handbook. How well it is adapted to this purpose is indicated by the fact that it has no index, a by-no-means-inclusive table of contents being the only guide to a mass of unclassified material, collected from a wide range

of treatises, and thrown together in anything but a systematic manner. The data thus gathered are such as can be found in most good engineers' handbooks, and in a much more handy form for practical use.

Raphael, F. Charles. The Localization of Faults in Electric-Light Mains. D. Van Nostrand Co., New York. "The Electrician" Publishing Co., Limited., London. 1897. Cloth, $2.

This book will supply a lack in the literature of electric engineering; for, although the subject of the localization of faults in telegraph cables has been extensively dealt with by able writers, the analogous treatment of faults in cables used for power and lighting has been neglected, probably under the mistaken impression that the analogies between conditions in the two classes of cables are closer than they really are. The differences in conditions are so great as alone to justify an intelligent and well-directed attempt to supply this hiatus in technical literature, and compelling changes in methods, partly depending upon different modes of insulation discussed (as belonging to the subject) in Chapters II and III. A method of testing a permanently-earthed network, which the author believes has not hitherto been used, is described on pages 50 and 61. A feature of the work is the grouping of the proofs of formulæ in a single chapter, instead of distributing them throughout the text. An original investigation relating to the accuracy obtainable from a given set of instruments, and a formula (deduced from fundamental bridge equations by the method used by Kempe in his "Handbook of Electrical Testing") for finding the possible degree of accuracy, may, it is thought, prove useful in ordering testing sets. In short, the matter, method, and style of publication render this book a desirable and commendable addition to current technical literature.

Reeve, Sidney A., M.E. The Entropy-Temperature Analysis of Steam-Engine Efficiencies. Progressive Age Publishing Co. New York. 1879. Cloth, 75c.

It is now generally acknowledged by the engineering profession that the entropy-temperature analysis of steam-engine tests comprehensively answers all questions relating to steam-engine efficiencies, in a manner incomparably more elegant than that which characterizes any other method of arriving at the required data. The labor of preparing for each analysis the required curves has heretofore been objectionable, and has, doubtless, much retarded the employment of this analysis. In *Engineering* (London), January 3, 1896, Professor Boulvin, of Ghent University, presented a diagram intended to obviate much of the labor of preparing the pre-requisite curves. The form of the diagram has since been modified by Professor Reeve, to render it much more convenient and exact for general use, and this modified diagram, with full explanatory text, constitutes the work under notice. We hazard nothing by saying that this small treatise, bringing, as it does, a scientific and valuable method within the practical reach of practising engineers, is an important contribution to steam-engine literature; it should be in the hands of every student of the science and practice of steam engineering.

American Plumbing Practice. A Selected Reprint from *The Engineering Record* (prior to 1887, *The Sanitary Engineer*) of Articles Describing Notable Plumbing Installations in the United States, and Questions and Answers on Problems Arising in Plumbing and House Drainage. *The Engineering Record*. New York. 1897. Cloth, $3.

The title so well indicates the contents that, the source of the articles being also named, there is scarcely need to say more to establish the value of the work. *The Engineering Record* has long been recognized, not only in the United States but also in Europe, as one of the highest American authorities in matters of sanitary and municipal engineering, in which the topics of heating, ventilation, and drainage have always occupied a position commensurate with their importance as health factors. Its discussions of principles and descriptions of appliances, installments, and details of plumbing and heating work have notably helped in the remarkable progress of the last quarter-century in these branches of engineering. It might well be expected that from the columns of a publication which has been so ably conducted through a long period a most interesting and valuable collection

of examples of plumbing practice could be culled, and a glance through the pages of the book is sufficient to show that such an expectation will be entirely satisfied. The explanations and descriptions, accompanied, as they are, by no less than 536 illustrations, are so plain that even the apprentices in the craft can read them understandingly, while at the same time they present to the adept a complete compendium of standard American practice in an art indispensable to sanitary construction, and one of whose recent marked advance its practitioners may well be proud. The book is a quarto of 260 pages, handsomely printed and bound.

BOOKS ANNOUNCED.

Tayler, A. J. Wallis. Motor Cars; or Power Carriages for Common Roads. Imported by C. Scribner's Sons, New York. 1897. Cloth, $1.

Andrews, G. Microscopic Fractures in Steel. Spon & Chamberlain, New York. 1897. Paper, 80 cents.

Andrews, G. Microscopic Fractures in Steel Rails and Axles. Spon & Chamberlain, New York. 1897. Paper, 40 cents.

Barber, F. Walter. The Engineer's Sketch-book of Mechanical Movements, Devices, Appliances, Contrivances, and Details Employed in the Design and Construction of Machinery for Every Purpose. Spon & Chamberlain, New York. 1897. Cloth, $4.

Blaine, Rob Gordon. Hydraulic Machinery. With an Introduction to Hydraulics. Spon & Chamberlain, New York. 1897. Cloth, $5.

Fuertis, Jas. H. Water and Public Health. The Relative Purity of Waters from Different Sources. J. Wiley & Sons, 1897. Cloth, $1.50.

Glover, Jas. Formulas for Railway Crossings and Switches. A Pocket-Book of Reference. Spon & Chamberlain, New York. 1897. Limp cloth, $1.

Parker, H. C. A Systematic Treatise on Electrical Measurements. Spon & Chamberlain, New York. 1897. Cloth, $1.

Robinson, Stillman Williams. Principles of Mechanism. John Wiley & Sons, New York. 1896. Cloth, $3.

Allen, J. A. Tables for Iron Analysis. John Wiley & Sons, New York. 1896. Cloth, $1.

Austen, P. T. Notes for Chemical Students. John Wiley & Sons, New York. 1896. Cloth, $1.50.

Bazin, H. Experiments upon the Contraction of the Liquid Vein Issuing from an Orifice, and upon the Distribution of the Velocities within It. Translated by J. C. Trautwine. John Wiley & Sons, New York. Cloth, $2.

Gargoyle, Solomon. Five Sins of an Architect. Essays. Arnold & Co., Philadelphia. 1897. Buckram, $1.

Gill, A. H. Gas and Fuel Analysis for Engineers. John Wiley & Sons, New York. 1896. Cloth, $1.25.

Stallard, J. H. The Problem of Municipal Government, as Illustrated by the Municipal Government of San Francisco. Reprint from *Overland Monthly*. Overland Monthly Publishing Company, San Francisco. 1897. Paper, 50 cents.

BOOKS RECEIVED.

Statistics of the American and Foreign Iron Trades for 1896. Being the Annual Statistical Report of The American Iron and Steel Association. Presented to the members, June 10, 1897. The American Iron and Steel Association, Philadelphia. Paper.

Mead, Elwood. Biennial Report of the State Engineer of Wyoming for 1895–96. Paper.

Morse, W. F. Cremation. The Disposal of Waste. Improved Garbage and Refuse Destructors. Disinfection by Streaming Steam Currents under Low Pressure. Sterilization by Formic Aldehyde Gas. Published by the author, 56 and 58 Pine street, New York. Paper.

Wilson, Herbert H. Pumping Water for Irrigation. No. 1 of Water-Supply and Irrigation papers of the U. S. Geological Survey. Department of the Interior, Washington. Gov't. Printing Office, 1896. Paper.

Campbell, A. W. Report of the Provincial Instructor in Road-Making, Ontario. Ontario Department of Agriculture. 1896. Paper.

History of the Baldwin Locomotive Works from 1831 to 1897. J. B. Lippincott Co., Philadelphia. 1897. This is an interesting narrative of the rise and progress of an important American industry, as exemplified in one of the most prominent manufacturing establishments of the entire world. The magnitude of the plant is indicated by the fact that it employs 5100 men. Thirty years were employed in building the first thousand engines, but almost as many were built in the single year begining the present decade, or an average of over three finished locomotives per day. The name of the author of the book has been, for some reason, withheld.

NEW CATALOGUES AND TRADE PUBLICATIONS.

These catalogues may be had free of charge on application to the firms issuing them. Please mention The Engineering Magazine when you write.

American Gas Furnace Company, New York. =(*a*) Pamphlet illustrated and describing the automatic fuel gas plants manufactured by this company (fifth edition). (*b*) Illustrated catalogue and price list of "Gas Blast" furnaces (fifth edition), for oil gas, illuminating gas, natural gas, etc. Illustrated pamphlet describing a new, reliable, noiseless high-pressure blower, applicable wherever a steady blast under definite pressure is needed. Six regular sizes are listed, with capacities and prices.

Hill, Clarke & Co., Boston, Mass., U. S. A.=(*a*) Important and handsome catalogue of 469 octavo pages, well and permanently bound in cloth, illustrating and describing (under the general title, "*Machinery Blue Book*") comprehensive lines of iron-working machine-tools, machine-shop supplies and pattern-makers' machinery. A feature of this "Blue Book," which, we judge, probably suggested its unique title, is the delicate tinting (by means of a second impression) of the cast iron parts of the machines illustrated, thus producing a novel, striking, and beautiful effect, and clearly distinguishing the cast-iron parts from parts made of other materials. (*b*) A telegraphic code for use in connection with the "Machinery Blue Book" above described

The Pittsburg Reduction Company, Pittsburg, Pa., U. S. A.=A trade treatise on Aluminium and Aluminium Alloys. It treats largely of the chemistry and metallurgy of aluminium and its present and ever-increasing industrial applications as a material in the useful and ornamental arts. Cloth, price $1.50 (distributed free to large customers). An examination of the table of contents shows that the amount of careful labor bestowed upon the preparation of this book, more than justifies the price. A very large number of carefully-prepared and -compiled data have been tabulated. Up-to-date information upon the subject of aluminium and other alloys, and methods of working these alloys as well as the pure metal, is supplied The effect upon cast iron of the introduction of aluminium is also discussed.

Buff & Berger, Boston, Mass., U. S A.=Catalogue and price list of astronomical instruments, engineers' transits and levels, and surveyors' instruments.

University of Wisconsin, Madison, Wis., U. S. A.=Catalogue for 1896–97.

Keuffel & Esser Company, New York; Chicago; St. Louis, Mo., U. S. A.=Illustrated catalogue and price lists of a leading and very extensive line of drawing materials and surveying instruments. The extent of this line may be estimated from the fact that 424 closely-printed octavo pages are required to contain the price lists, illustrations, and descriptive text, making it one of the most important catalogues of this class of goods issued in the United States.

The Reeves Pulley Company, Columbus, Ind., U S. A.=Illustrated catalogue of the "Reeves Patent Split Pulley."

Jenkins Bros., New York.=Catalogue for 1897. Illustrates and describes the long list of valves for general and special use now manufactured by this firm, inclusive of a new-comer, the "Excelsior" back pressure valve, the manufacture of which by this firm has been recently commenced.

The Rollins Engine Co., Nashua, N. H.=Elegantly-printed illustrated catalogue describing the Rollins steam engine in detail, and presenting testimonials from users.

Boston Belting Company, Boston and New York, U. S. A.=Pamphlet and catalogue of the rubber mats, matting, and treads, with illustrations of styles, descriptive text, and price-lists—an elegant trade publication.

The Goheen Manufacturing Co., Canton, Ohio, U. S. A.=Pamphlet entitled "The Ex-Rays Turned on our Sky-Scrapers"; in which is voiced public alarm at the corroded state in which the iron work of some tall buildings has been found, and in which the merits of "Goheen's Carbonizing Coating" as a protective agent for guarding iron structural work against corrosion, from atmospheric influences is discussed.

The J. W. Ruger Manufacturing Company, Buffalo, N. Y., U. S. A.=Catalogue describing and illustrating gas engines, and, more especially, the new engine made by this firm, which embodies improvements and up-to date features.

The Battle Creek Steam Pump Company, Battle Creek, Mich., U. S. A.=Illustrated descriptive catalogue of the "Marsh" steam pump as manufactured for different uses, in pumping water, syrups and other thick liquids, milk, oil, naphtha, etc., with dimensions, capacities, and price-lists.

Fred. M. Locke, Victor, N. Y., U. S. A.=Catalogue of high-insulation line material, with cuts and descriptions of insulators and appliances.

Strange Forged Twist Drill Company, New Bedford, Mass., U. S. A.=Price-list of forged twist drills, drill-chucks, reamers, and other machinists' tools.

Charles P. Willard & Company, Chicago, Ill., U. S. A.=Catalogue with illustrated descriptions of steam yachts, steam launches, and yacht appliances, manufactured by this firm. Details of construction, size, and capacity are presented.

The Whitlock Coil Pipe Company, Elmwood, Conn., U. S. A.=(*a*) Catalogue and price list of the American feed-water heaters and purifiers, illustrative and descriptive. (*b*) Smaller catalogue, letter-envelope size, illustrating and describing the same articles as above. (*c*) Illustrated price-list iron, steel, brass, and copper pipe coils.

For additional catalogues, see page 32, under Improved Machinery.

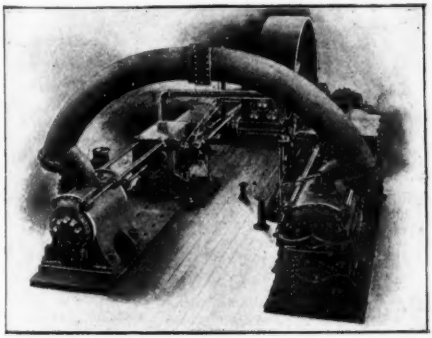
IMPROVED MACHINERY

NEW PROCESSES. NEW APPLIANCES.

The matter published in this department is not paid for, nor can it be classed as advertising. But as the information is necessarily obtained from those who offer the appliances for sale, it is proper to say that the manufacturers, rather than ourselves, are responsible for the statements made.

The Largest Compressor Engine in Canada.

THE compressor engine shown in the engraving, is the largest ever put in operation in Canada, and recently installed at the famous Le Roi mine, Rossland, B. C., was built by the Rand Drill Company, of 100 Broadway, New York City, in their Canadian shop at Sherbrooke, P. Q., It is a beautiful piece of mechanism, as seen standing on the shop floor. The steam engine is a cross compound condensing machine of the Corliss type. The high pressure cylinder is 22 inches in diameter by 48-inch stroke, taking steam through a pipe 6 inches in diameter. The low pressure



THE LARGEST COMPRESSOR ENGINE IN CANADA.

cylinder on the opposite side of the machine is 40 inches in diameter by 48 inch stroke. Both cylinders are fitted with the Corliss liberating type valve, with vacuum dash pot, and with a sensitive governor operating on the release gear, to be operated automatically from six or eight revolutions to the maximum number of revolutions per minute. The main shaft is 14 inches in diameter by 13 feet long, weighing about 5,500 pounds, and fitted with cranks pressed on. The connecting rod forgings and piston rod forgings are well and carefully finished.

The air end of the machine is fitted tandem with the steam cylinders, and is also compound, the high pressure air cylinder being 22 inches in diameter by 48-inch stroke. The valve motion supplying these cylinders is Rand's most economical type, being in the form of mechanical valves. By this means the filling of the low pressure cylinder with air at atmospheric pressure is insured, which largely affects the efficiency of the machine; for, were the cylinder either not completely filled, or were the air hot and expended, in just such a ratio would the efficiency be decreased. The inlet valves of the low pressure or intake air cylinder are surrounded by a hood which is connected to a flue for the introduction of the cold air from out of doors. Between the high and low pressure cylinder is an intercooler of the latest type Through this intercooler the air passes over a system of water-circulating pipes and is cooled in the process. This giant compressor engine will be used for running all the pumps and hoists at the mine in addition to operating 40 drills.

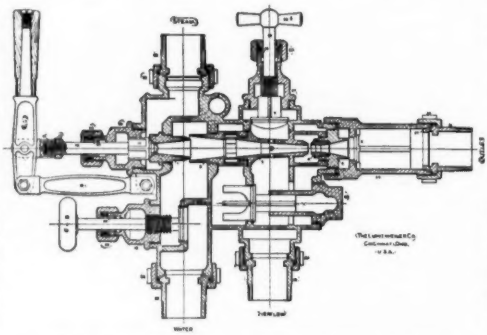
A Broad Decision In an Infringement Patent Suit.

A BILL in appeal having been filed in the circuit court of the United States for the eastern district of Pennsylvania, by the Ewart Manufacturing Company (whose general agents are the Link Belt Engineering Co., of Philadelphia) against James H. Mitchell, to enjoin the alleged infringement of the claims of letters patent No. 264,139, issued September 12,1882, to James H. Dodge for an improvement in Chain Cables, generally known as the "Dodge Chain," that court was of the opinion that Mitchell's device did so infringe, and decreed an injunction. The respondent appealed from this decree, and the case went before the court of appeals for review, and Judge Buffington decided in favor of the Dodge patent, using the following language: "In our judgment the device shown by Dodge's patent was novel in character, disclosed an invention of very decided merit, and was a substantial advance over mechanical constructions theretofore used in the art to which it appertained, and the claims of the patent should have such a construction as will

give the patentee the full benefit of the advance which he has contributed to the mechanical arts, and claimed." He states that the differences in the respondent's device are only apparent and superficial, and he affirms the opinion of the lower court that Mitchell's device is an infringement of Dodge's patent.

The Lunkenheimer Automatic Single-Tube Injector.

THIS is an automatic, single-tube machine of the fixed nozzle type. Should the machine stop forcing (from interruption of steam or water supply) the injector will restart without attention as soon as the supply is resumed. When the injector "breaks" from stoppage of water supply, the steam will not go down the suction pipe, thereby heating the water and rendering it too hot to work (or where supply is taken through a meter injuring the same), but will blow through the injector into the atmosphere, thereby creating a strong draft through the machine. When the water-supply is resumed it will come up to the injector, which will start at once to force it into the boiler without any attention from the operator. Many injectors are claimed to be automatic in action, but few are really so, and most of those which do approach an ideal performance of this feature soon wear out; the part which makes them automatic, *i. e.*, the check valve, closing the overflow chamber between water lifting and combining tubes, either cuts out or scales up. In the Lunkenheimer automatic injector this valve is so made that it will not cut-out and even though it should not be perfectly tight it will not materially impair the working of the machine. It is claimed to be the only durable automatic injector on the market. It has no delicate or complicated mechanism, the several parts are large and easy of access for examination and repairs without the use of special tools. Owing to its construction the injector will start promptly at all steam pressures from 30 lbs. up to 250 lbs., and higher on lifts not exceeding 18 feet. It is not necessary to prime it in starting, as the single movement of the lever is sufficient to admit steam and the water is promptly lifted to the injector, which will at once start work.



LUNKENHEIMER'S AUTOMATIC SINGLE-TUBE INJECTOR.

The injector is very prompt and positive in its action. Its capacity may be reduced fifty per cent. from the maximum, the operation being just as steady as when at maximum delivery. Its working range is claimed to be equal to that of any injector on the market. Much care and study have been devoted to its design, particularly in properly proportioning tubes and internal valves. In the claims for its durability and reliability due allowance has made for average practical conditions.

This injector, it is claimed, is the only one on the market combining with its other regular working qualities an adaptability to places wherein it is desirable to wash and test boilers. The workmanship and materials are of the best quality, and the injector is adapted to all kinds of service, whether locomotive, marine, or stationary, giving equal satisfaction in all kinds of service.

Forced Draft for Combustion of Culm.

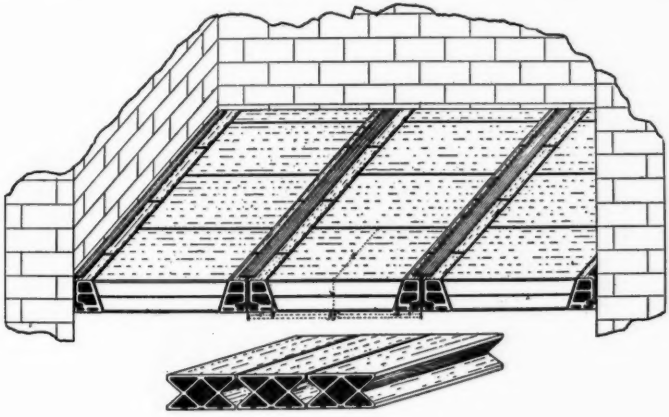
THE Buffalo Forge Co. (corner of Broadway and Mortimer Streets, Buffalo, N. Y., U. S. A.) having several years ago installed one of their forced draft plants for the Williamsport Steam Company, Williamsport, Pa., now send us an extract from a letter received from the latter, very highly commending the plant, expressing great satisfaction with its operation, stating that "it has proved itself" to be "a great saver in fuel expenses," and promising to "speak well for the plant to any one making inquiries." There is no dispute of the fact that modern engineering tends more and more to artificial draft, and that the steam jet blower, though it demonstrates the value of a forced draft, is not generally held to be the ideal means for creating such a draft. Modern practice seems to have proved that in the combustion of culm the use of fans for forcing draft is preferable to the steam jet, and we believe this view is held by most consumers of culm, in sections where large accumulations of this fuel render it cheap and easily attainable, as in the eastern part of Pennsylvania and other coal mining re-

gions. The success of the forced draft plants installed by the Buffalo Forge Company justifies us in bringing them to the attention of those now using culm as fuel, or contemplating such use.

Eureka Hollow Tiles, for Light Floor Construction.

THE engraving illustrates the construction of a light floor made of the "Eureka" hollow patented tiles manufactured by Henry Maurer & Son, 420 East Twenty-third street, New York.

The design is that of an arch, composed of three tiles set between 5 in. or 6 in. deep beams, and consists of two abutments, or "skewbacks," which fit the beams, thoroughly protecting the lower flanges, and a centre or "key" brick. The tiles, being hollow longitudinally, adapt themselves readily to the tie-rods, without cutting. To insure a perfect and well-constructed arch of this design, it is absolutely necessary that the iron beams be spaced either 30 in. or 32 in. centres. Tiles made in *one* piece, owing to their length, are liable to frequent breakage, entailing the loss of an entire tile, whereas in this method, there being three distinct pieces, should either end-brick get broken, only 4 in. are lost.



EUREKA HOLLOW TILE.

An arch is much stronger than any single tile spanning the entire distance between beams. The "Eureka" adds the advantage that, as the entire depth of the beams is filled in, the cost of labor and material for concreting are wholly saved. In calculating for a design, especially for floors, no allowance should be made for the strength of the concrete, but the cement covering should be considered so much extra load on the system. It is the usual custom, in designing a fire-proof system, to consider that the concrete bears its share of the loads upon the girder, and in a great many cases the girder is designed on that assumption. If no fire occurs this is all right, but it is specifically against that element that the "Eureka" system furnishes a safeguard. If a severe fire occurs, the concrete loses its cohesive properties, both on account of the loss of its water hydration and the great internal strains caused by the expansion of one side under heat, and consequently becomes unable to resist stress anywhere near what it was originally able to bear, and in most cases would not even be self-supporting. Experiments have shown that sudden heat is extremely ruinous, much more so than heat gradually applied; and in an average fire a very high temperature is generated in an incredibly short time, and concrete subjected to its action would, very soon, be unable to bear any strain whatever. A fire of ordinary intensity is sufficient to ruin completely a very large covering of concrete, and water applied to hot cement is extremely ruinous.

The "Eureka" system is simplicity itself; as the tiles cannot work loose, no centring or cement is required, and the ease and rapidity of setting it (equal to two and one-half times that of any other construction of its kind) will recommend it to all seeking a light floor construction, cheap, while thoroughly fire-proof, and capable easily of sustaining a load of from 150 to 200 pounds per square foot. The manufacturers are placing this construction on the market, in full confidence that it will fully meet all demands and requirements for light fire proof flooring.

NEW CATALOGUES AND TRADE PUBLICATIONS.

These catalogues may be had free of charge on application to the firms issuing them.
Please mention The Engineering Magazine when you write.

Sullivan Machinery Company, Chicago, Ill., U. S. A.=Catalogue No. 28, May 1, 1897. Illustrates and describes the "Sullivan" rock drills, and diamond drills, "Sullivan" channeling machines, and other mining and quarrying tools, appliances, and supplies, giving also tabulated dimensions, weights, specifications, and price lists.

Best Telephone Manufacturing Company, Baltimore, Md., (U. S. A.=(*a*) Elegantly-printed pamphlet, entitled "How the Best Telephones are Made: Told from Photographs." The half-tone illustrations accompanying the descriptive text are taken from parts of the company's factories, and the whole forms an interesting booklet. (*b*) Circular, illustrating and describing a telephone for the use of divers on the ocean's bottom, and entitled "Deep-Sea Talking."

The Stiles and Fladd Press Company, Watertown, N. Y., U. S. A.=Catalogue, remarkable for its extent, considering that this company shipped its first machine about May 1, 1896. The catalogue comprises an extensive line of drop-hammers, dies, and special machinery for metal-working, which tools are illustrated and described. Prices and dimensions are also presented.

Semi-Steel Company, King and Andrews Company, Chicago, Ill., proprietors Birmingham Iron Foundry, Derby, Conn., U. S. A. Licencees.=Pamphlet describing the properties of the so-called semi-steel, and presenting comparisons of its strength with best grades of cast-iron, chill roll iron, gun-carriage metal, car-wheel iron, heavy-machinery, stove-plate iron, and Bessemer iron. Testimonials from users.

The Cleveland Stone Company, Cleveland, Ohio, U. S. A.=Illustrated descriptive catalogue of grindstones for all purposes, and mounted grindstones for hand and power use; with specifications and price-lists.

The Vitrified Wheel Company, Westfield, Mass., U. S. A.=Illustrated and descriptive catalogue of "New Process" porous vitrified emery and corundum wheels.

The Goulds Manufacturing Company, Seneca Falls, N. Y., U. S. A.=(*a*) Catalogue illustrating and describing a line of power-driven water-supply and tank pumps, with tables of sizes, capacities, etc. (*b*) Similar catalogue of boiler-feed pumps. (*c*) Similar catalogue of paper-mill stuff and suction pumps.

Reading Crane and Hoist Works, Reading, Pa., U. S. A.=Catalogue and price-list (for 1897) of hand-power travelling cranes and jib cranes, portable chain hoists, overhead tramways, and general hoisting machinery.

The Egan Company, Cincinnati, Ohio, U. S. A.=Large illustrated poster catalogue of wood-working machinery, to be posted in prominent places for reference.

Munn & Co., New York.=(*a*) Catalogue of books recently published. (*b*) "Scientific American Hand book on Patents, Caveats, and Trade-marks. (*c*) Catalogue of papers contained in Scientific American Supplement. (*d*) Catalogue of scientific and technical books published, imported, and sold by this firm.

The Garvin Machine Co., New York.=Illustrated descriptive catalogue of the extensive line machine tools manufactured by this company.

Ross & Company, London.=(*a*) Pamphlet illustrating and describing the electric arc light for lantern projection, the Ross-Hepworth arc lamps, and new patent "Ecentrical" carbons. (*b*) Pamphlet illustrating and describing the photoscope and its uses. (*c*) Circular announcing prizes for a photoscope competition. (*d*) Circular illustrating and describing the "Ross New Model" binocular field glass. (*e*) Circular relating to the Ross-Zeiss Convertible Anastigmats. (*f*) Circular containing tables of contents of different catalogues published by this firm.

Standard Underground Cable Company, Pittsburg, New York, Chicago, and St. Louis, U. S. A.="Pocket Handbook," containing useful information, price-lists, telegraph code, relating to lead-covered cables, insulated wires, etc.

Baldwinsville Centrifugal Pump Works, Irvin Van Wie, proprietor, Syracuse, N. Y., U. S. A. =Catalogue H., illustrating and describing centrifugal and "Triplex" pumping machinery, pumps, gasoline engines, boilers, fittings, etc.

R. K. LeBlond, Cincinnati, Ohio, U. S. A.= Catalogue illustrating the "LeBlond" machine tools, and special machine-shop labor-saving appliances.

The Eynon-Evans Manufacturing Company, Philadelphia, Pa., U. S. A.= (*a*) Catalogue (third edition) illustrating and describing specialties manufactured by this firm in the lines of hydraulic machinery, bronze founding, etc. (*b*) Circular relating to Smurthwaites "Old Reliable" steam-trap. (*c*) Circular setting forth eight points of merit of the "Eynon-Korting Compound Injector.

The Jeffrey Manufacturing Company, Columbus, Ohio, U. S. A.=Catalogue of chain belting and steel cable elevating and conveying machinery.

Anglo-American Cycle Fittings Company, New York.=Catalogue illustrating and describing cycle material specialties—parts and fittings.

Charles H. Besley & Co., Chicago, Ill., U. S. A.—Catalogue illustrating and describing an extensive line of manufacturers' and machinists' hardware, fine tools, and supplies.

Wiley and Russell Manufacturing Co., Greenfield, Mass., U. S. A.=Catalogue of patent screw-cutting and other labor-saving machinery and tools.

For additional catalogues see page 676, under Books of the Month.